ENGINEER ANALYSIS OF THE 9TH INFANTRY DIVISION
(MOTORIZED) (91D(MTZ)) VOLUME 1(U) ARMY ENGINEER
STUDIES CENTER FORT BELVOIR VA   D K LEHMANN ET AL.

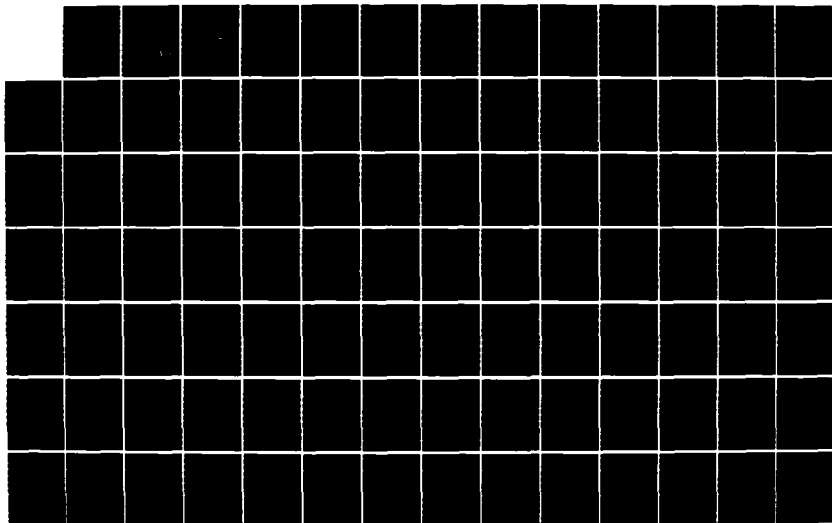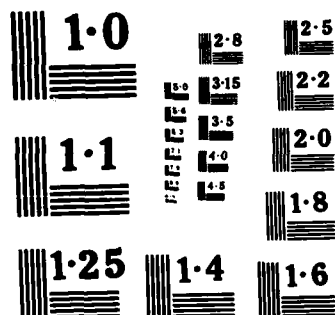UNCLASSIFIED   NOV 85 USAESC-R-85-15-VOL-1   F/G 15/5   NL

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ENGINEER ANALYSIS

OF THE

9TH INFANTRY DIVISION (MOTORIZED)

(9ID(MTZ))

Volume I

Prepared by
Engineer Studies Center
US Army Corps of Engineers

December 1985

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   This study analyzes the engineer requirements of the 9ID(MTZ) in two 1986 scenarios, and determines the engineer force needed to support the division. The analysis refines the division engineer battalion organization and develops the engineer augmentation that is required for EAD. The general study methodology compares engineer requirements with engineer capability. The requirements are unconstrained but realistic. They are calculated on site with no degradation, while capability is degraded with

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20. ABSTRACT (Cont)

commonly accepted factors such as casualties and movement. As a result, the
comparison provides time-phased estimates on what requirements can be accom-
plished in priority order. SWA and Europe scenarios, gamed by the DIME
model, are used to generate engineer requirements. Detailed engineer
requirements (including artillery and aviation mine requirements) are cal-
culated for personnel and mission-essential equipment in consecutive time
periods. For each time period, requirements and capability are tracked for
each of the forward brigades plus the DRA. Engineer tasks are further
grouped and compressed into increments ranked for lodgement, offense, and
defense battle phases. The requirements are split between the 9ID(MTZ)
(base case) and EAD units (augmentation case) working in the division area
of operation. Findings and conclusions address shortfalls, organizational
discrepancies, and support requirements from EAD engineer resources. Recom-
mendations are based on constraints of not increasing personnel or C-141
sorties of the divisional engineer battalion and minimizing the size of the
engineer EAD force.

ENGINEER ANALYSIS OF THE 9TH INFANTRY DIVISION (MOTORIZED)

(9 ID (MTZ)) (U)

VOLUME I

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Engineer Studies Center

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CONTENTS

EXECUTIVE SUMMARY

1. The 9ID(MTZ), including its organic 15th Engineer Battalion, is the only unit of its kind. The mission of this division is to rapidly deploy and defeat tank and motorized enemy forces in various contingency areas or NATO. The division is optimized for combat in open terrain with a large AO where it can achieve maximum combat effectiveness through force mobility. This study examined this unique divisional concept in its design organization to determine what role, organization, and structure is appropriate for divisional and EAD engineers. The study was sponsored by the Army Development and Employment Agency (ADEA).

2. Very early in the study, it became apparent that engineer counter-mobility and mobility missions greatly overshadowed survivability tasks for motorized operations. It was determined that the divisional engineer counter-mobility capability to rapidly emplace linear obstacles could best support operations in the roadless terrain typical of many contingency areas such as SWA. This roadless terrain uses all the division's engineer, artillery, and aviation scatterable mine assets to achieve the desired division mobility advantage over threat forces. These mine assets are one of the division's dominant strengths. In Europe, the terrain is open, but criss-crossed with many paved roads. This AO is relatively small, but the requirement to block the developed roadnet consumes substantial amounts of engineer resources. These two contrasting sets of theater requirements were weighted 2:1 in favor of SWA over Europe to provide a common requirements base for divisional engineer battalion design recommendations.

3. Using weighted scenario requirements, ESC determined who generated engineer requirements, where those requirements were located, and if time was available to complete them. Only the requirements generated by vital and critical priority group tasks were considered appropriate for the design of the engineer force structure because of the short scenario battle phases. These two priority groups contain engineer tasks that work towards the prevention of early defeat or high loss of life.

   a. The study determined that the division could, under either scenario, accomplish all lodgement tasks. It was concluded that it takes three engineer battalion-days to install the initial Covering Force Area obstacle plan under either scenario.

   b. The study recommends that the divisional engineers should be designed to accomplish forward brigade tasks. The most important forward task is in the zone where counterattacks are being executed. Counterattack support constituted only 3 percent of the total workload, but because of its high priority, was allocated 15 percent of the divisional engineers' current TOE capability. However, counterattacks used all of the battalion's ACEs; ESC recommends the number of battalion ACEs be increased.

   c. The remainder of the requirements in the brigade areas comprised 32 percent of the total workload. The divisional battalion could only complete about half of the vital priority portion of this workload. ESC

recommended no change in the 152-man squad power of the battalion, but recommended that mix and distribution of the battalion's 68 major pieces of equipment be changed. The number of 5-ton trucks were increased, as were the number of ACEs. The number of SEEs and LABS were reduced; two Volcanos were added (replacing two MICLICs); and four SEEs were converted from anti-tank ditch to general purpose use. These changes do not alter the battalion's C-141B deployability profile.

d. The DRA requirements constituted 65 percent of the total workload. This requirement, plus half the brigade vital and all critical tasks, were beyond the divisional engineers' capability and therefore were assigned to engineer EAD units. To meet those requirements, ESC calculated that seven EAD engineer battalions were required for SWA; five for Europe. ESC also recommended EAD mission, squad-power, and equipment mix changes. These EAD changes considered the requirements of other divisions ESC had examined in other, similar studies for the US Corps in Europe. The mission changes recommended assigning a surge survivability capability for two EAD equipment companies (TOEs 5-54J and 5-58H) that included the addition of SEEs. ESC recommended the removal of new road and airfield construction missions from three units (TOEs 5-54J, 5-58H, and 5-195J), and changed the movement criteria of two units (TOEs 5-54J and 5-195J) from airdrop and slingload capabilities to C-141B transportability. Equipment changes were recommended for all EAD units, standardizing construction vehicle capacities and adjusting equipment levels to match requirements. These recommended EAD changes do not increase existing unit strengths. The EAD units must be designed to accomplish the full range of engineer support tasks throughout the entire corps area; therefore, EAD changes considered all four priority group requirements.

4. ESC's findings constitute a data base that can be adjusted if motorized concepts or equipment characteristics change in the future. The study conclusions are based on scenario assumptions that reflect the latest AirLand Battle and support doctrine. ESC's recommendations depend on doctrine, TOEs, and most importantly scenario conditions. The requirements generated by the scenarios and the resulting conclusions and recommendations of the study outline rather general recommendations that enhance the engineer support to the division. No attempt is made to recommend detailed line item changes to the divisional engineer battalion's TOE. ESC's recommendations can be used by TOE designers to test or establish the best distribution of engineer soldiers and equipment for the eventual motorized division organization.

5. The motorized concept satisfies the Army's strategic and tactical objectives in new and exciting ways. At the same time it provides future challenges for both the operator and planner that range from testing the best training techniques to embracing optimum engineer equipment.

LIST OF ABBREVIATIONS AND ACRONYMS

```
abn...............airborne
ACE...............armored combat earthmover
ADA...............air defense artillery
ADAM..............Area Denial Artillery Munition
ADEA..............Army Development and Employment Agency
AFM...............Air Force manual
AFPDA.............Army Force Planning Data and Assumptions
AG................Adjutant General
AHB...............attack helicopter battalion
ALO...............authorized level of organization
AO................area of operation
AOS...............air operating surface
AP................anti-personnel
APC...............armored personnel carrier
AR................Army Regulation
ASR...............ammunition supply rate
AT................anti-tank
ATP...............ammunition transfer point
AVLB..............Armored Vehicle Launched Bridge


bde...............brigade
BMP...............Boyevaya Maschina Pekhoty (Soviet armored personnel carrier)
bn................battalion
BSA...............brigade support area


CAB...............Combined Arms Battalion
CACDA.............Combined Arms Combat Development Activity
CASC..............Corps Area Signal Center
CATK..............counterattack
cav...............cavalry
CBAA..............cavalry brigade air attack
CCM...............cross-country movement
CENTAG............Central Army Group
CFA...............covering force area
Co................company
const.............construction
CONUS.............Continental United States
CP................command post
CSE...............combat support equipment
CSH...............combat support hospital


DA................Department of the Army
DCD...............Directorate Combat Developments
DIME..............division map exercise
DIO...............Directorate of Industrial Operations
DISCOM............division support command
Div...............division
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DOD..............Department of Defense
DRA..............division rear area
DS/GS............direct support/general support

EAD..............echelons above division
EEA..............essential elements of analysis
EFFORT...........ESC Factor Force Readiness Tabulation
E-FOSS...........Engineer Family of Systems Study
EH...............evacuation hospital
EOD..............explosive ordnance disposal
EPW..............enemy prisoner of war
equip............equipment
ERP..............engineer release point
ESC..............Engineer Studies Center


FA...............field artillery
FACE.............forward aviation combat engineering
FARRP............forward area refueling and rearming point
FASCAM...........Family of Scatterable Mines
FC...............Field Circular
FDC..............fire direction center
FEBA.............forward edge of battle area
FLOT.............forward line of own troops
FM...............field manual
ft...............feet


GDP..............general defense plan
GEMSS............Ground-Emplaced Mine Scattering System


HHC..............headquarters and headquarters company
HMMWV............high mobility multipurpose wheeled vehicle
HN...............host nation
HNS..............host-nation support


ID-Day...........Invasion D-Day
I/EW.............intelligence and electronic warfare
IPR..............In-Process Review


km...............kilometer
km$^2$...........square kilometer
kph..............kilometer per hour
kVA..............kilovolt-ampere


LAB..............light assault bridge
LAPES............Low Altitude Parachute Extraction System
LAV..............light armored vehicle
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lb................pound
LEWR..............lightweight early warning radar
LFV...............light forces vehicle
LOC...............lines of communication


m.................meter
MAB...............mobile assault bridge
MAOS..............minimum air operating surface
MBA...............main battle area
MICLIC............mine clearing line charge
MLRS..............multiple launch rocket system
mm................millimeter
MOPMS.............Modular Pack Mine System
MP................Military Police
MSR...............main supply route


NATO..............North Atlantic Treaty Organization
NBC...............nuclear, biological, chemical
9ID(MTZ)..........9th Infantry Division (Motorized)
NORTHAG...........Northern Army Group


PGATM.............precision-guided antitank munition
PLS...............Palletized Loading System
POL...............petroleum, oils, and lubricants
POM...............Program Objective Memorandum
POZ...............Podvizhnoy Otriad Zagrazhdeniya (mobile obstacle detachment)
PSYOP.............psychological operation


RAAM..............remote anti-armor mine
RC................reserve component


SAG...............Study Advisory Group
SEE...............small emplacement excavator
spt...............support
SWA...............Southwest Asia


TAA...............tactical assembly area
TEXS..............tactical explosives system
TM................technical manual
TOC...............Tactical Operations Center
TOE...............table of organization and equipment
TOW...............tube-launched, optically tracked, wire-guided missile
TPFDD.............time-phased force deployment data
TRADOC............US Army Training and Doctrine Command
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USACE.............United States Army Corps of Engineers
USAES.............United States Army Engineer School
UXO...............unexploded ordnance

VAC...............volts, alternating current

I. INTRODUCTION

1. **Purpose.** This study analyzes the engineer requirements of the 9ID(MTZ) under two 1986 scenarios, and determines the overall engineer force capabilities required to support the division on the battlefield.

2. **Background.**

a. The new operating concept for the evolving motorized infantry division has significantly changed the division's organic engineer battalion. Among these changes are mandatory manpower and deployability constraints, which have reduced the size of the battalion and diminished the capability of the division's engineers.

b. On 16 August 1984, MG Robert W. Riscassi, the Commander of the ADEA (which oversees the design, development, and testing of the 9ID(MTZ)) wrote MG Richard M. Wells, Deputy Commander, USACE, asking for his help in conducting a study to definitively measure the impact of the 9ID(MTZ)'s new engineer organizational design on the division's operations. MG Wells responded to that request by tasking ESC with a comprehensive assessment of the 9ID(MTZ)'s engineering capabilities and requirements under two likely combat scenarios with very different deployment and battlefield conditions.

c. In August 1984, ESC published a study plan for the project, outlining its intentions of evaluating the division's ability to complete survivability, mobility, countermobility, and general engineering tasks under the scenarios to be selected by ESC and approved by the project's SAG. That plan was accepted at the SAG's first IPR in September 1984.

d. Between the study's first IPR in September and the second IPR in January 1985, ESC's study team visited the 9ID(MTZ) to collect information on the division's engineer requirements. During this same time, ADEA drafted a

priority list for three of the combat phases to be considered by the study using an incremental task priority system developed by ESC for a series of earlier studies which assessed the combat engineer requirements of the III, V, and VII US Corps in Europe.[1]

e. An SWA scenario was approved by the SAG at the second IPR, and a European scenario was approved at IPR 3 in April 1985. A final draft of the study was completed and presented for comment at IPR 4 in July 1985.

3. Scope. As a requirements-based study, the focus of this effort was to:

a. Find the time-phased mix of engineer units needed to satisfy the engineer requirements within the AO of the 9ID(MTZ).

b. Suggest changes to the division's engineer units and EAD that would enhance their engineering capability to support the division.

4. Organization. Volume I of this report is UNCLASSIFIED. It describes the study's methodology and summarizes significant findings, conclusions, and recommendations. A series of annexes gives the details of each step in the assessment and describes the new structures ESC recommends be considered for the division's organic battalion and EAD units. Volume II, which is classified SECRET, gives the details of the SWA and European scenarios that were the basis of this analysis.

5. Assumptions and Their Significance.

a. ASSUMPTION: The organization of the 9ID(MTZ) is fixed as of November 1984 and identifies all equipment that will be available to the

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[1]DA, USACE, ESC, Analysis of III Corps Combat Engineer Wartime Requirements, Analysis of V Corps Combat Engineer Wartime Requirements and Analysis of VII Corps Combat Engineer Wartime Requirements (hereafter referred to as III Corps, V Corps and VII Corps studies). For more detailed information on these and all references following, please see Annex J (Bibliography).

2

division between 1986 and 1990. SIGNIFICANCE: This assumption tests the division's existing design capability, ignoring any surrogate items of equipment which could be added later because of a change in the division's design, a technology breakthrough, or delays in developing new equipment.

b. ASSUMPTION: Engineer requirements are developed based on two DIME scenarios[2] and the division's operational concept, as published by ADEA in its three-part coordinating draft, dated 2 April 1984.[3] SIGNIFICANCE: The scenarios provide a wide range of terrain and combat conditions upon which to base study conclusions. Both documents also rank engineer requirements for the analysis team. Where concepts are either changing or can be interpreted differently, they were tested by using additional study excursions developed especially by the study team for this analysis.

c. ASSUMPTION: The EAD units working within the division AO are defined by the High Technology Light Division Combat Effectiveness Study[4] prepared by the BDM corporation. SIGNIFICANCE: Corps engineer capability and EAD requirements were compared only for post-D-Day operations, since the scenarios did not list theater arrival dates for EAD units.

6. Essential Elements of Analysis.

a. This analysis was driven by three key EEA:

(1) What should the division's engineer role be in the use of scatterable mines, considering the capabilities of air- and artillery-delivered scatterable mines?

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[2]DA, TRADOC, CAORA, High Technology Light Division Combat Effectivenss Study, (HTLD-CES, Mid-East Scenario) (hereafter referred to as HTLD-CES).

[3]DA, ADEA, Operational Concept--9th Infantry Division (Motorized)--Part I, The Division Concept; Part II--Unit Concepts; Part III--Equipment and Systems Concept.

[4]BDM Corporation, HTLD Combat Effectiveness Study, Blue Force Open Terrain Scenario, and HTLD Combat Effectiveness Study, Blue Force Closed Terrain Scenario.

(2) Which engineer missions are appropriate to the divisional engineer battalion?

(3) Which engineer structure is appropriate for an EAD force in the SWA theater? Which for the European theater?

b. All three questions raised issues which fell somewhat outside the guidelines usually set for a formal capability assessment. The first required that ESC do a logistical analysis of the stockage, use, and transportation of Class IV and V material (Annex G); the second raised an issue that required several study excursions, careful SAG review, and a constrained battalion redesign to resolve (Annex I). To answer the third question, the study team structured two engineer EAD deployment lists, each appropriate to a different theater. Corps engineer units common to both EAD lists were analyzed, adjusted, or realigned as appropriate (Annex H).

7. Study Methodology.

a. Figure 1 shows the general study methodology used to compare engineer requirements with engineer capability for the SWA and European scenarios. The requirements were unconstrained, but realistic; they were calculated at the work site, assuming the best size workforce. Capability was degraded by such commonly accepted factors as casualty and movement rates. The result was a time-phased estimate of what engineer requirements can be executed in which order during the battle phases of each scenario.

b. ESC's study team asked ADEA's staff to rank each of the division's expected engineer tasks, by battle phase for each scenario, using a special task ranking system developed by ESC. Figure 2 briefly defines each priority group in ESC's ranking system; Figure 3 is a consolidated version of the rankings selected by ADEA for the 9ID(MTZ) under the scenarios considered

4

STUDY METHODOLOGY FOR EACH SCENARIO

*The European scenario has a fifth AO for the CBAA. In this scenario, the CBAA is assigned missions with distinct tactical boundaries.

Figure 1

5

PRIORITY GROUPS

Short Title	Implications of Nonsupport
Vital	Jeopardizes the existence of the division High loss of life Early defeat of the division
Critical	Failure of division operations Increased probability of defeat
Essential	Short-term degradation in sustainability Significant equipment and material losses
Necessary	Long-term degradation in sustainability Moderate equipment and material losses

Figure 2

CONSOLIDATED PRIORITY LIST

Rank	Priority Group	Increment* Lodgement	Increment* Offense	Increment* Defense
1	Vital	M-1	M-1	C-1
2	Vital	G-1	M-2	C-2
3	Vital	C-1	M-3	C-3
4	Vital	C-2	G-1	S-1
5	Critical	G-3	G-2	G-1
6	Critical	M-2	C-1	G-2
7	Critical	G-2	G-3	G-3
8	Critical	S-1	S-2	S-2
9	Essential	S-2	S-1	S-3
10	Essential	M-3	C-2	M-3
11	Essential	C-3	C-3	M-1
12	Essential	S-3	S-3	M-2
13	Necessary	M-4	S-4	G-4
14	Necessary	S-4	G-4	S-4
15	Necessary	G-4	--	M-4

*Corresponds to the increment levels in each functional area (e.g., C-1, means countermobility tasks, first increment). S--Survivability; C--Countermobility; M--Mobility; G--General Engineering

Figure 3

6

by this analysis. A detailed description of each functional area increment is given in Annex C (Mobility), Annex D (Countermobility), Annex E (Survivability) or Annex F (General Engineering).

c. Figure 4 summarizes the two study cases and the five additional study excursions the study team used to address the issues raised in both the study's general methodology and by the EEA. (Annex A gives complete details of each study case and excursion.) In Case I, the base cases for each scenario, only the 9ID(MTZ) and its organic engineer battalion are available to undertake the division's engineering tasks. In Case II, the augmentation cases, the engineering capability of the division's battalion is augmented by one corps battalion. In brief, the study excursions look at:

STUDY CASES AND EXCURSIONS

| | Engineer Capability | | Force Requirements | | | |
| | | | Div | | EAD | |
Case/Excursion	Div	EAD	Bde	DRA	Bde	DRA
Case I (Base)	X		X	X		
Case II (Augmentation)	X	X	X	X	X	X
Excursion A (2 Engineer Bns)	X	X	X	X		
Excursion B (Brigade Effort)	X		X		X	
Excursion C (DRA Effort)		X		X		X
Excursion D (Priority Work)*	X	X	X	X	X	X
Excursion E (Direct-fire weapons)*	X	X	X**	X	X	X

*Vital and critical priority groups only.
**DRAGON and vehicle anti-tank weapons are dug in.

Figure 4

(1) The impact an attached engineer corps battalion has on accomplishing division-generated requirements (Excursion A).

7

(2) The effect of dividing engineer capability by placing the division's engineer battalion forward to work only on requirements in the brigade area (Excursion B).

(3) The impact allocating all EAD engineer support units to the DRA has on accomplishing requirements (Excursion C).

(4) The impact of using the total engineer capability on only vital and critical tasks (Excursion D).

(5) The effect of digging in direct-fire anti-tank weapons (Excursion E).

d. Two subject areas of analysis could not be calculated under either study case or the five excursions: separate methodologies were created for determining the requirements of bridging and Class V engineer materiel. Bridging requirements were determined by actual site selection (see Annex C), while Class V mining and MICLIC requirements (Annex G) were determined by identifying actual tonnages for engineer Class V items from the mobility and countermobility analyses (Annexes C and D). These tonnages then were compared to tonnage delivered from the existing ASRs; new ASRs were created within their logistical constraints for each theater.

II. FINDINGS

8. <u>Format of Analysis Results.</u>

a. Figure 5 is an example of the sliding bar charts developed to graphically compare how engineer capability was allocated during each battle phase of each scenario. As much information as possible was compressed onto each chart to completely record the results of the analyses of each different case and excursion for the SWA and European scenarios. Squad- or equipment-hours are listed on the vertical axis of the charts and are expressed as per-day averages to make it easier to compare time periods of varying lengths (horizontal axis). The top of the bars within the chart shows the available squad (or equipment) capability within the time period. For example, in Figure 5, there are 3,000 and 3,500 hours per day per time period available to do work.

b. The bar charts also show how requirements were subtracted, in priority order, from the available hours-per-day capability using the four priority groups in ESC's task ranking methodology—vital, critical, essential, and necessary. The point at which the bar crosses the zero axis indicates where available capability is exhausted. The segment below the axis represents shortfall (i.e., requirements which cannot be met). If the bottom of the bar is above the zero axis in any time period, then all requirements can be met in that period. Blank space between the bar and the zero axis means there is surplus capability within a time period.

c. In the example in Figure 5, the available capability indicated on the first bar is only sufficient to meet vital and critical requirements and to complete the most important one-third of the essential tasks. The rest of the essential and all of the necessary tasks cannot be performed. The bottom

9

of the bar shows the total shortfall is 5,000 hours per day. However, the capability indicated on the second bar is enough to complete tasks in all four priority groups and still leave a surplus capability of 500 hours.

CAPABILITY VERSUS REQUIREMENTS SLIDING BAR CHART EXAMPLE--
Squad- or Equipment-Hours
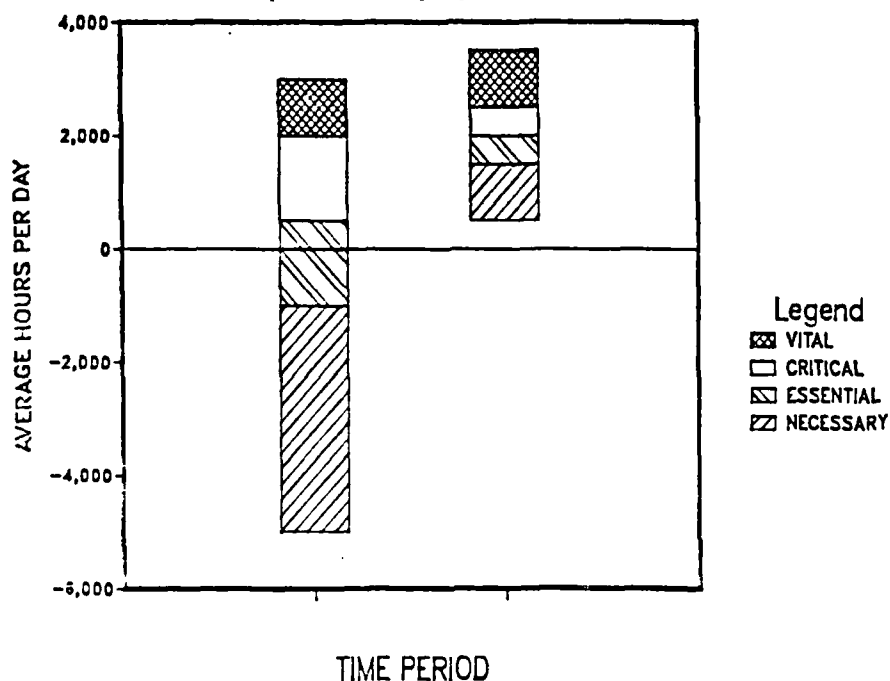
Figure 5

9. <u>General Capability Results.</u>

a. During Case I in each scenario (the base cases), the engineer capability of the 9ID(MTZ) is the same: 15th Engineer Battalion, 9ID (MTZ). This unit has 476 individuals and deploys in 55 C-141B sorties. During Case II for each scenario (the augmentation cases), the 15th Engineer Battalion is joined by a corps engineer battalion. Under the SWA Case II, an active army battalion with 706 individuals deploys to SWA; under the European Case II, a National Guard battalion with 749 individuals deploys to Europe. Both these battalions arrive via sea.

10

b. Figure 6 shows the combined engineer capability for the division's 15th Engineer Battalion and its augmentation battalion, in average squad- and equipment-hours by battle phase, for the SWA scenario. Figure 7 shows the same information for the 15th and its augmentation battalion from the National Guard for the European scenario. Note that both scenarios only augment the division's organic engineer battalion with an additional corps battalion after H-Hour; this limitation is imposed by the scenario models.

c. Several capability trends were common to both scenarios.

(1) The average engineer capability during deployment is moderate. This is because the engineers deploy in increments over a 14- to 15-day period.

(2) The divisional battalion's engineer capability is highest in the CFA because the battalion has been fully deployed and few, if any, engineer casualties have resulted during the CFA action.

(3) Engineer capability in the MBA declines as a direct result of casualties; the scenario models do not replace casualties.

10. SWA Scenario--Capability Versus Requirements.

a. Capability. Figures 8 through 13 display the results of the capability versus requirements comparisons made for each battle phase of the SWA scenario. Figures 8 and 9 show the squad-hour results; Figures 10 through 13 the results for the equipment-hour analyses. The equipment-hour charts are presented in pairs: the first figure in each pair (Figures 10 and 12) shows the average for all five of the scenario's time periods; the second figure in each pair (Figures 11 and 13) enlarges Periods 1 (Deploy), 2 (CFA), and 5 (H+36>60 Delay). Several trends appear in all charts, regardless of whether the results are for squad- or equipment-hours.

SWA ENGINEER CAPABILITY
CASES I AND II
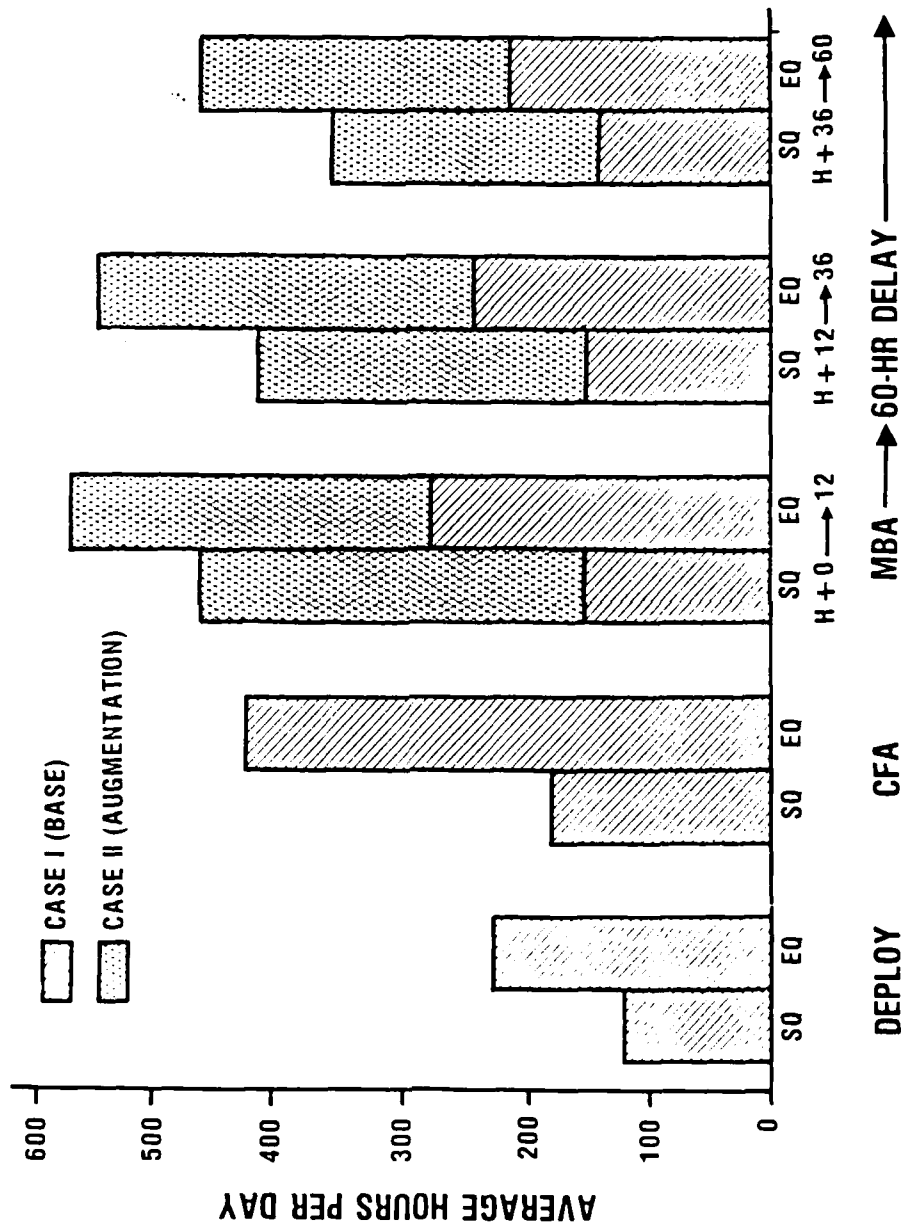
Figure 6

EUROPE ENGINEER CAPABILITY
CASES I AND II
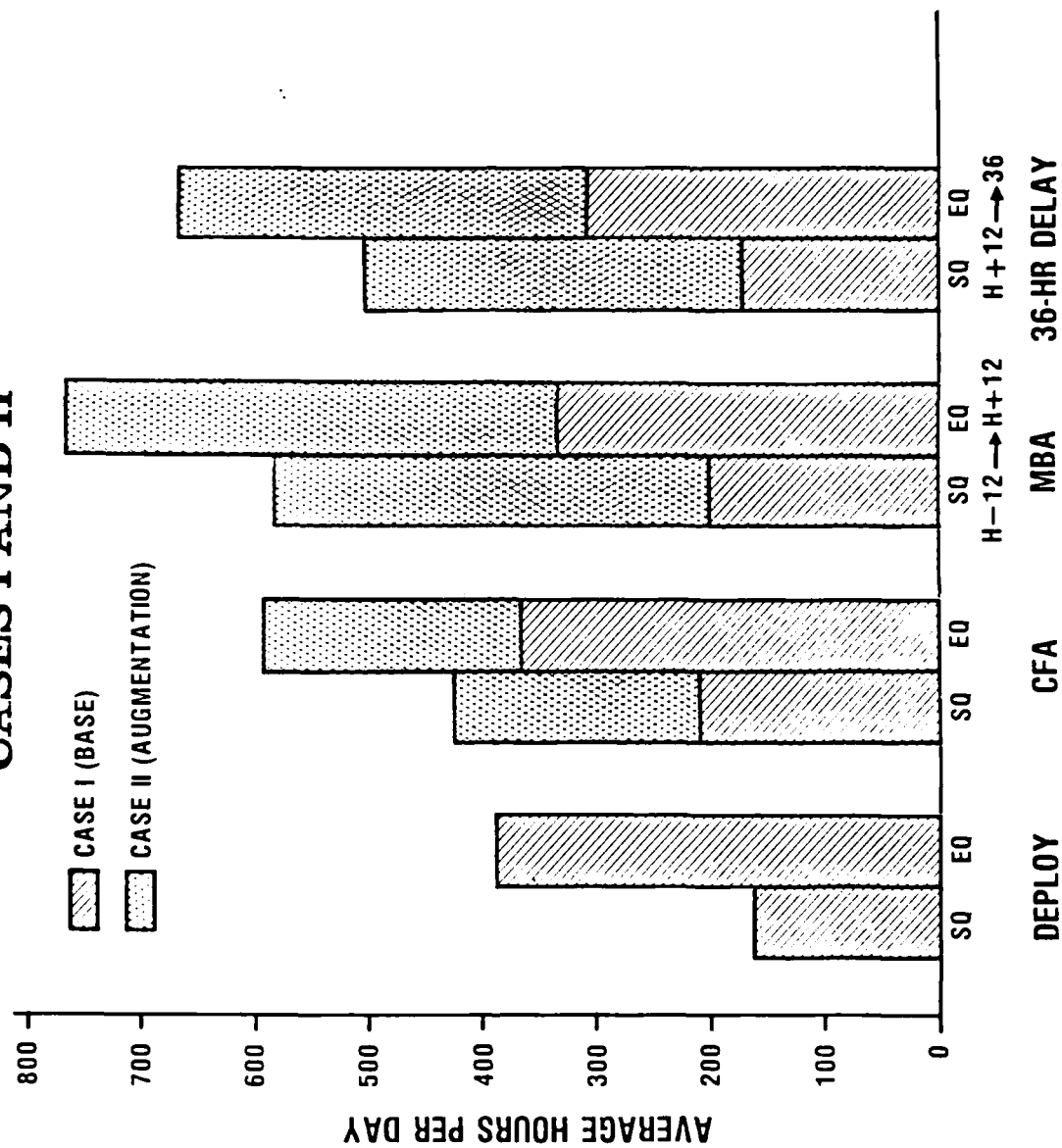
Figure 7

AVERAGE HOURS PER DAY

SWA DIVISION CAPABILITY AND REQUIREMENTS—
Case I (Base)
(Squad-Hours)

SWA 60-HR DELAY
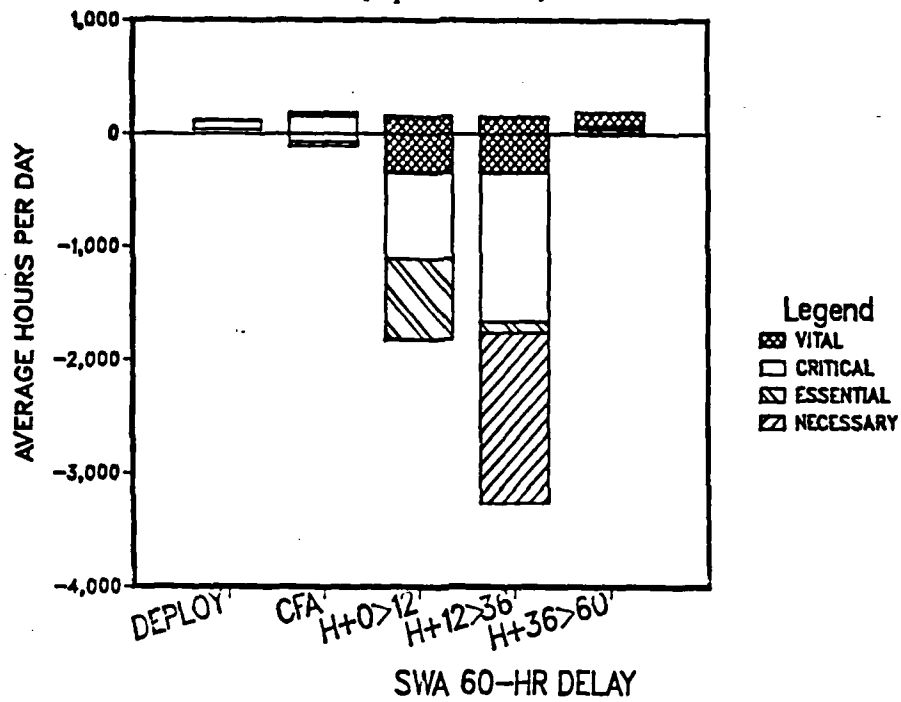
Figure 8

SWA EAD CAPABILITY AND REQUIREMENTS—
Case II (Augmentation)
(Squad-Hours)

SWA 60-HR DELAY

Figure 9

14
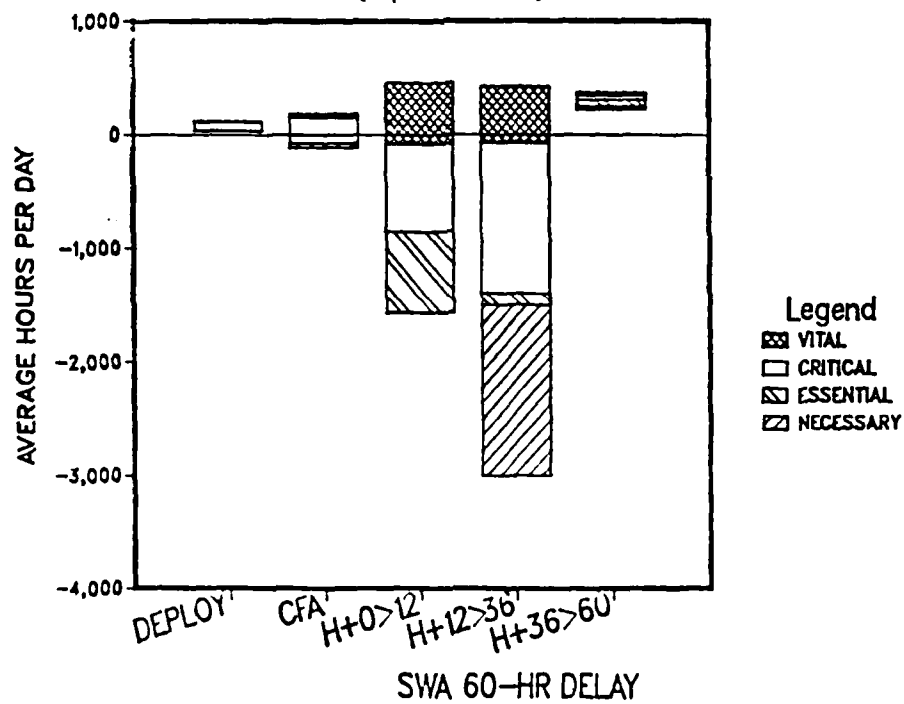
SWA DIVISION CAPABILITY AND REQUIREMENTS
FOR ALL SCENARIO PERIODS—
Case I (Base)
(Equipment-Hours)
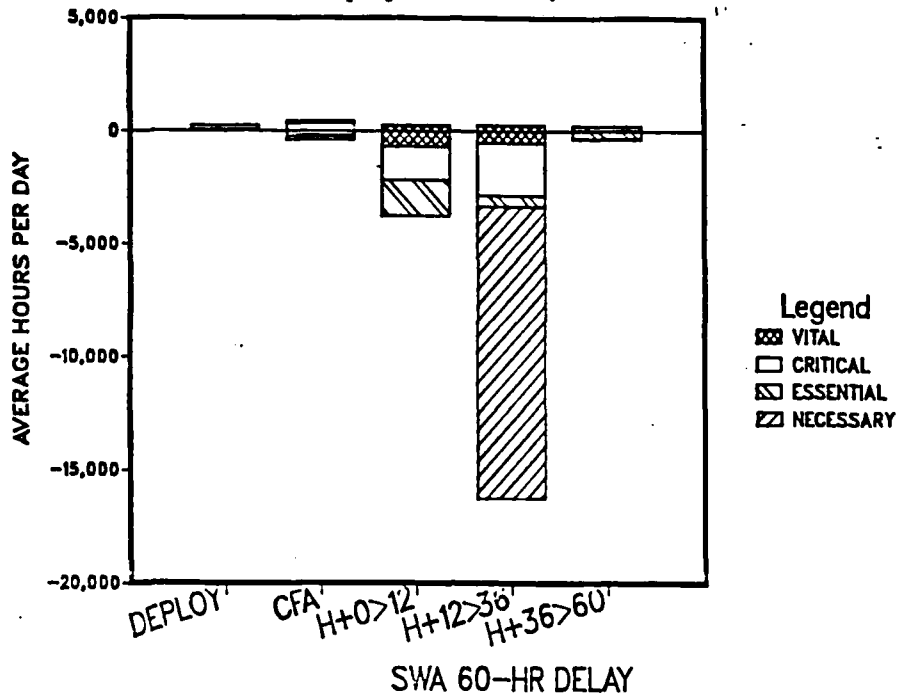
Figure 10

SWA OVERALL DIVISION CAPABILITY REQUIREMENTS
FOR SCENARIO PERIODS 1, 2, AND 5—
Case I (Base)
(Equipment-Hours)

Figure 11

15
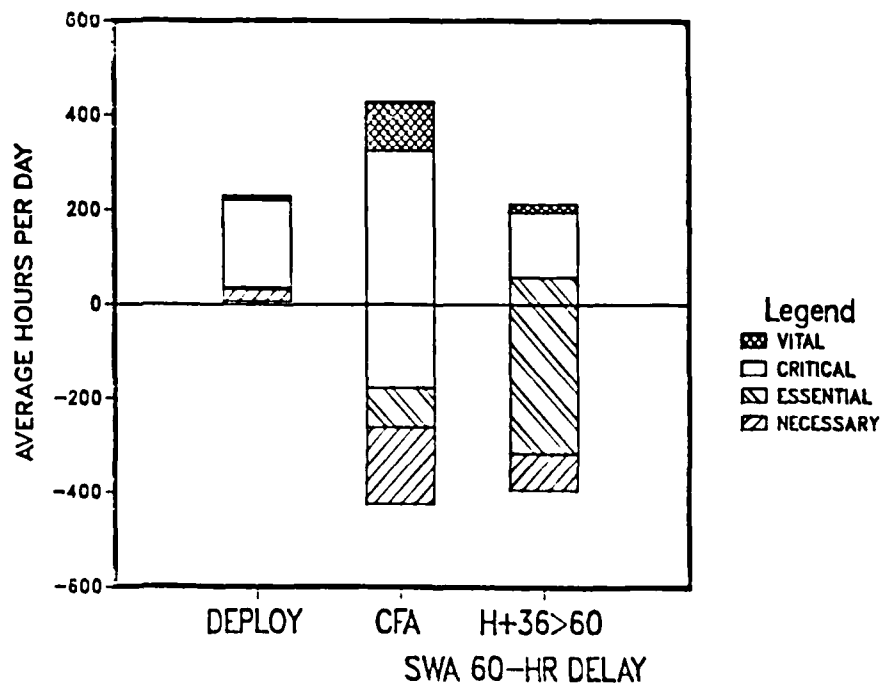
SWA EAD CAPABILITY AND REQUIREMENTS
FOR ALL SCENARIO PERIODS—
Case II (Augmentation)
(Equipment-Hours)

Legend
VITAL
CRITICAL
ESSENTIAL
NECESSARY

SWA 60-HR DELAY
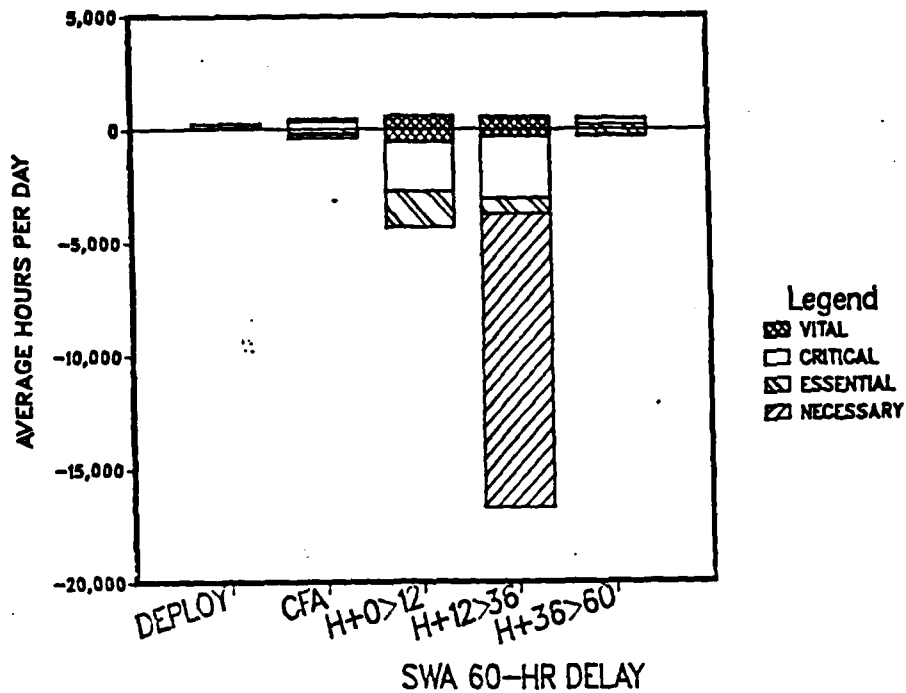
Figure 12

SWA EAD CAPABILITY AND REQUIREMENTS
FOR SCENARIO PERIODS 1, 2, AND 5—
Case II (Augmentation)
(Equipment-Hours)

Legend
VITAL
CRITICAL
ESSENTIAL
NECESSARY

SWA 60-HR DELAY

Figure 13

16
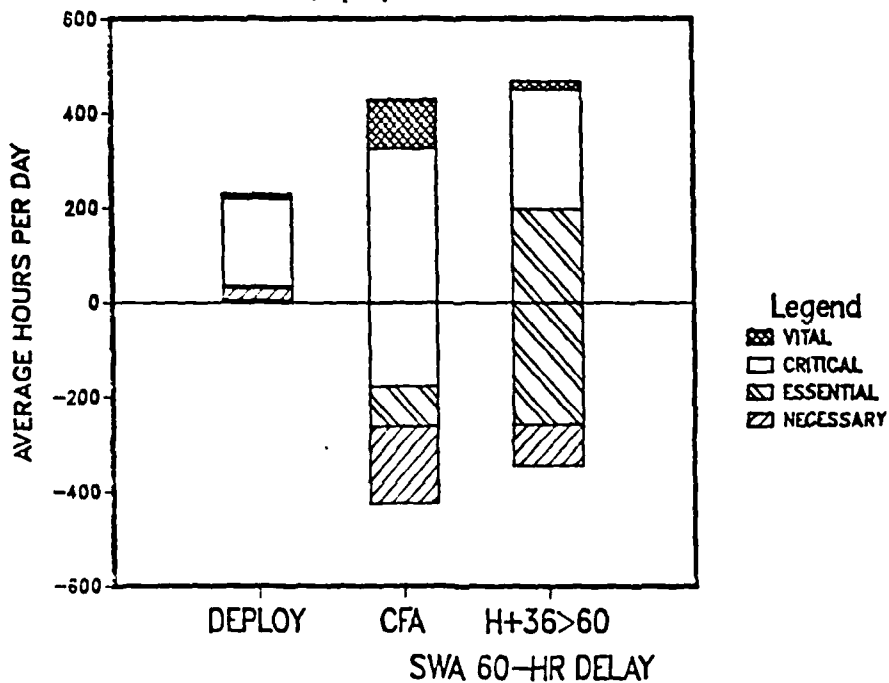
(1) During Period 1, the deployment and lodgement phase, all tasks are completed, leaving only an insignificant surplus of capability. The length of the period seems to have the most influence on this outcome--the 15 days which comprise Period 1 are enough time to collect the resources necessary to meet all the period's engineering requirements. This observation means the divisional engineer battalion can successfully move the division from the lodgement airhead over a 600-km road to the division AO. The conditions of this period are the same for Cases I and II.

(2) During Period 2, the CFA phase, engineers prepare the battlefield for 3 days, with no enemy contact. All vital tasks are completed, including the entire obstacle plan, but only about 65 percent of the critical tasks are finished. Like Period 1, the conditions of this period are the same for Cases I and II. Because of the shortfalls experienced in this period, engineers are prevented from starting earlier any tasks expected during the MBA delay phase of the scenario.

(3) Period 3 is the start of the 60-hour MBA delay and the only time the division is on the offense; therefore, it is the only period where the offense priority list is used. Depending on whether Case I or II is considered, there are only enough squad- and equipment-hours available to complete between 27 and 85 percent of the vital tasks. These vital tasks include all engineer mobility missions. No effort is available for the three remaining priority groups. The shortfall here shows the impact of a limited engineer EAD force structure on the division's engineer capability.

(4) Period 4 continues the 60-hour MBA delay, but operations switch from the offense to defense as division casualties increase. Again, as in Period 3, only a portion of the vital tasks can be completed--ranging

17

between 29 and 85 percent, depending on whether Case I or II is considered and whether the analyses results are displayed as squad- or equipment-hours. The vital tasks include all engineer-emplaced obstacles. During this period, the maneuver force is forced to give up the most terrain. The battlefield has enough depth to allow additional engineer EAD units working space, if they were available.

(5) Period 5 is the final withdrawal of the 60-hour MBA delay as the division looses approach 60 percent. This period also used the defensive priority list, but with a greatly reduced requirement shortfall. There are enough squad-hours available to complete 36 to 100 percent of the engineering tasks through to the final necessary priority group. Equipment-hours run out in the critical priority group (Figure 11) or the essential priority group (Figure 13). This period has artificial scenario conditions that make it atypical. For example, during this final period:

(a) The division is restricted by a natural barrier on its rear boundary. As a result, engineers can no longer construct the next fall-back obstacle phase-line.

(b) Division strength reaches 40 percent, reducing the few recognized engineer survivability missions by 60 percent.

(c) The threat force bypasses the division on both flanks, which drastically reduces the engineer's MSR network as the division is forced to defend an area only one-fourth that of previous periods.

b. Requirements. Figure 14 shows the Case II divisional engineer requirements for all five of the scenario periods, grouped into different categories.

(1) More than 95 percent of all requirements are generated by divisional units. This means the engineer EAD capability can be allocated

against division requirements. It also explains why the results of Case I and Case II are so similar during Periods 3, 4, and 5.

DISTRIBUTION OF THE SWA SCENARIO'S DIVISIONAL AO REQUIREMENTS
(Percentage)

| Requirement | Hours | |
Group*	Squad	Equipment
Force:		
Divisional Units	99	95
EAD Units	1	5
Priority:		
Vital	15	8
Critical	51	31
Essential	9	10
Necessary	25	51
Battle Zone:		
Brigade Areas	32	22
Division Rear Area	68	78
Time:		
Deployment and CFA	31	22
60-hour delay	69	78

*All groups are based on a sum of all five scenario time periods in Case II (Augmentation).

Figure 14

(2) The remaining categories of priority groups, battle zone areas, and time before and after D-Day help explain the extreme shortfalls at the start of the MBA delay. This is indicated strongly in the fact that about 75 percent of the scenario requirements occur after deployment and CFA operations. The priority and battle zone groups, when considered with post-D-Day operations, show where the shortfalls are located (for more detail see Annex I).

11. European Scenario--Capability Versus Requirements.

a. Capability. Figures 15 through 18 compare engineer capability to requirements for Cases I and II of the European scenario. As with the SWA scenario, the two cases exhibit the same trends:

19

EUROPEAN DIVISION CAPABILITY AND REQUIREMENTS—
Case I (Base)
(Squad-Hours)
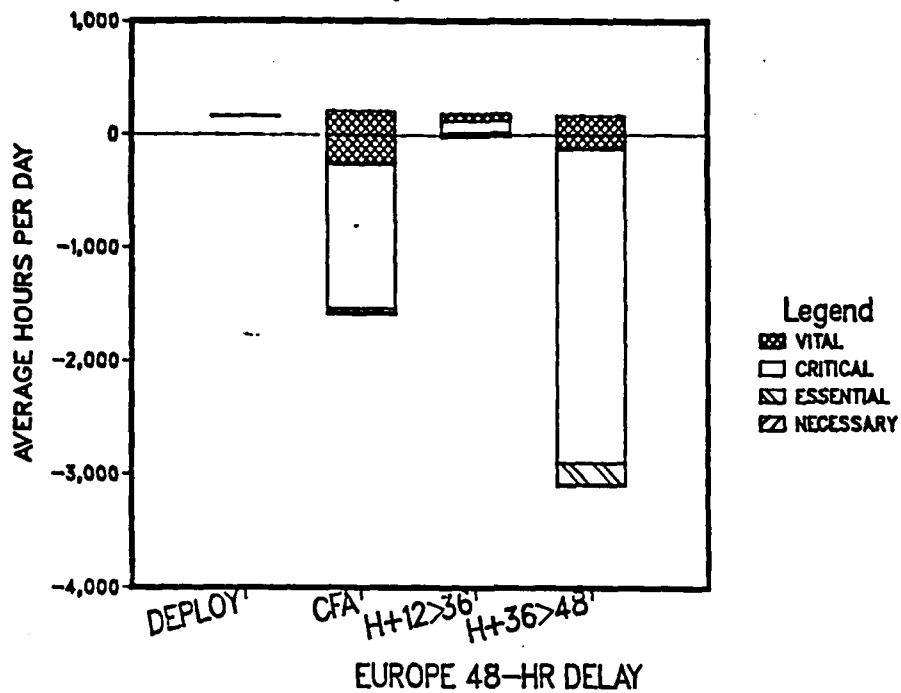
Figure 15

EUROPEAN DIVISION CAPABILITY AND REQUIREMENTS—
Case I (Base)
(Equipment-Hours)
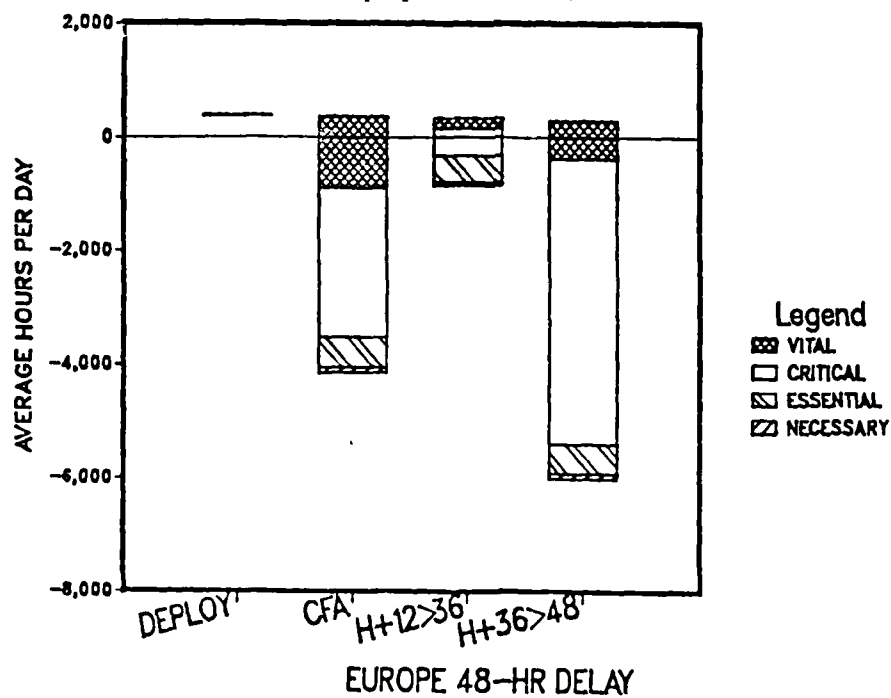
Figure 16

20

EUROPEAN EAD CAPABILITY AND REQUIREMENTS—
Case II (Augmentation)
(Squad-Hours)

EUROPE 48-HR DELAY
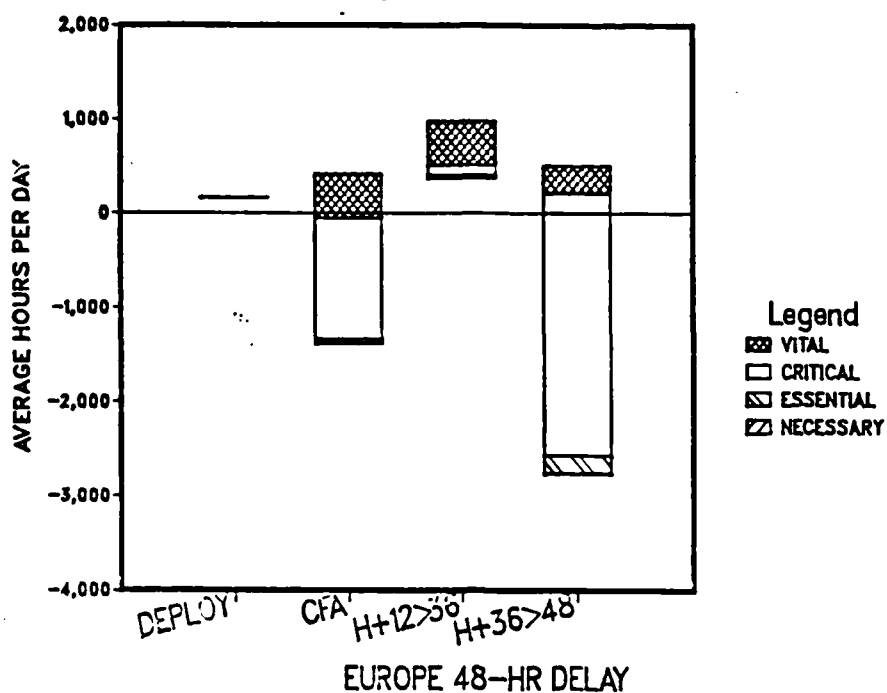
Figure 17

EUROPEAN EAD CAPABILITY AND REQUIREMENTS
Case II (Augmentation)
(Equipment-Hours)

EUROPE 48-HR DELAY

Figure 18

21
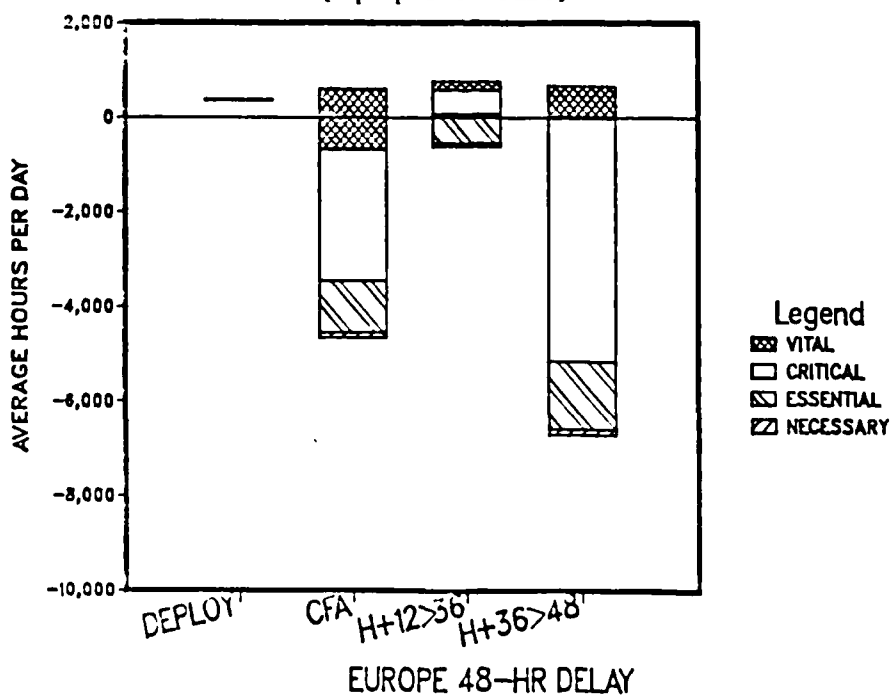
(1) During Period 1, the lodgement phase, the division has more engineer capability than it needs to meet its immediate requirements. (Unfortunately, the scenario did not allow the division to spend this excess capability by having the engineers begin installing the obstacle plan, although this would have been desirable.) There are few lodgement tasks because:

(a) The division is inserted into its AO by air; this avoids long road marches and eliminates the requirements for many engineer mobility tasks.

(b) The European scenario portrays a mature theater with an extensive road network and other host-nation facilities.

(c) The III US Corps has already deployed into the same area, so there is an existing support network ready to greet the 9ID(MTZ) when it arrives.

(2) During Period 2, engineers have 12 hours to prepare the battlefield and 12 hours more to help the CBAA delay in the CFA. This is not enough time in which to complete the obstacle plan; the engineers simply do not have the equipment-hours (mostly internal transport 5-ton trucks) to meet all the plan's requirements. However, if two engineer battalions were available and if the 12-hour nonbattle phase were extended 24 more hours to 36 hours, it is likely the engineers would gain the capability they need to execute the obstacle plan on time.

(3) Period 3 is the first 24 hours of the MBA delay. There is little FEBA movement this day and consequently few engineer tasks. The squad-hours that are available are adequate to meet requirements through essential tasks in Case I and through necessary tasks in Case II. Equipment-hours run out sooner in both cases: only vital tasks are completed in Case I and there

22

only are enough equipment-hours to meet demands through critical tasks in Case II. The unexecuted essential tasks prevent the engineers from providing any mobility support to the division.

(4) During Period 4 the FEBA moves rapidly, relocating brigade and division boundaries and requiring extensive engineer work. In Case II, the division can only complete its vital tasks, even though it has the capability of two engineer battalions to spend. In Case I, the divisional engineer battalion can execute only about 50 percent of the vital tasks by itself. (In both cases, damage repair and expedient construction of critical facilities is unexecuted.) If the battalion could have used the capability expended on essential and necessary work in Period 3 during Period 4, then up to half the critical tasks of Period 4 could have been executed. However, there is no reason the events of Period 4 could have been foreseen during Period 3.

b. Requirements. Figure 19 shows the Case II divisional requirements for all four time periods, grouped into different categories.

(1) About 90 percent of all requirements are generated by division units; this result is similar to the results of the SWA scenario analysis, where more than 95 percent of all requirements were generated by division units.

(2) A sophisticated and extensive road network and the availability of some host-nation support reduces the number of essential and necessary tasks the engineers must complete.

(3) The engineers' workload is evenly divided between the time up to the completion of the CFA operation and the time of the MBA delay. This can be explained by the the nature of the CFA fight, which attempts to channel the enemy towards a kill zone.

23

DISTRIBUTION OF THE EUROPEAN SCENARIO'S DIVISIONAL AO REQUIREMENTS
(Percentage)

| Requirement | Hours | |
Group*	Squad	Equipment
Force:		
Divisional Units	99	86
EAD Units	1	14
Priority:		
Vital	19	17
Critical	75	57
Essential	4	24
Necessary	2	2
Battle Zone:		
Brigade Areas	24	42
Division Rear Area	76	58
Time:		
Lodgement and CFA	50	51
MBA delay	50	49

*All groups are based on a sum of all time periods per each Case II (Augmentation) scenario.

Figure 19

12. <u>EAD and Divisional Engineer Force Structure Proposals--Methodology.</u> This study determined an engineer force structure for meeting the vital and critical demands of the "key" situation of each scenario. A key situation was defined as those important combat periods that are typical, contain augmentation force requirements, and exhibit a shortfall in engineer capability. Both of the key situations selected for each scenario contained part or all of the MBA delay battle periods and measured the full range of engineer capabilities.

a. For the SWA scenario, the key situation was during Periods 3 and 4, the first 36 hours of the MBA delay. Period 5 was excluded because it was considered to present an atypical situation (see para 10a(5)).

b. For the European scenario, the key situation was during Periods 2, 3, and 4, the 48-hour delay (12 hours in the CFA and 36 hours in the MBA).

Period 3 was included, even though its shortfall is very small, to give a complete picture of the demands made on the force structure's capability.

c. For each scenario key situation, the engineer equipment- and squad-hour shortfalls were compared to the capabilities of all EAD engineer organizations to identify the most suitable candidates. The selection and timing of individual units followed priorities based on completing vital before crtical requirements, and brigade before DRA requirements (Annex H describes these priority lists in detail).

13. EAD Design Proposal.

a. Figure 20 shows the engineer EAD force structure for the SWA scenario; Figure 21 shows the proposal for the European scenario. The needs for each scenario are, in order of importance:

(1) Both scenarios need one more corps engineer battalion to meet the most important vital tasks for the key MBA delay periods. This unit should be present at D-Day and must be allocated primarily to the forward brigades.

(2) Under the SWA scenario, the division needs an engineer airborne package (one battalion plus one light equipment company) to complete vital DRA tasks. The SWA package should be airlifted into the AO, as needed. Under the European scenario, however, the division can do without the engineer airborne package, since there are no vital DRA tasks.

(3) The scenarios differed on the force required to complete critical forward area tasks. The SWA scenario required a corps engineer battalion, while the European scenario needed only one CSE company. These units should have a high priority for ocean shipment.

(4) Both scenarios need three more corps battalions to complete critical DRA tasks, plus either one or two CSE companies, depending on the

25

SWA ENGINEER EAD PRIORITIES

Ranked Unit Packages (Noncumulative)	Engineer Unit			
	Abn Bn	Light Equip Co (Abn)	Corps Bn	CSE Co
Priority 1--Minimum Essential at D-Day	--	--	1	--
Priority 2--for Immediate Air Shipment	1	1	--	--
Priority 3--for Immediate Ocean Shipment	--	--	1	--
Priority 4--for Available Ocean Shipment:				
Increment A	--	--	1	1
Increment B	--	--	2	1
Cumulative Total	1	1	5	2

Figure 20

EUROPEAN ENGINEER EAD PRIORITIES

Ranked Unit Packages (Noncumulative)	Engineer Unit			
	Abn Bn	Light Equip Co (Abn)	Corps Bn	CSE Co
Priority 1--Minimum Essential at D-Day	--	--	1	--
Priority 2--for Immediate Ocean Shipment	--	--	--	1
Priority 3--for Available Ocean Shipment:				
Increment A	--	--	2	--
Increment B	--	--	1	1
Cumulative Total	--	--	4	2

Figure 21

scenario. The CSE units should be shipped in increments of one CSE company for every two battalions. Both scenarios require two increments.

b. The ranked unit packages identified above are the most efficient force, based on total squad- and equipment-hours. However, the current EAD units do not have the best distribution of equipment, as shown in Figure 22. The EAD equipment mix analysis considered all tasks, since these units also support the CRA area. The starting point for all these equipment mix changes were based on previous ESC III Corps, V Corps and VII Corps studies for Europe, including Engineer Assessment, Europe.[5] ESC has determined that equipment requirements for EAD units are similar for all divisions and theaters. Figure 23 summarizes the equipment changes proposed for engineer EAD units. The current structures of the airborne engineer battalion and light equipment company equipment were adjusted to meet the requirements of the SWA scenario using C-141B transport. The corps battalion and CSE company adjustments were based on both scenarios, but the requirements of the SWA scenario were weighted twice that of Europe in order to favor the divisional operational concepts. The divisional operational concept favors vast open and roadless terrain and a mechanized heavy threat force that were only characteristic of the SWA scenario. For each scenario, the combined mix of two battalions plus one company was used to match the weighted requirement mix. Figure 24 shows how the missions of these units could change to take advantage of the new capability offered by modifying the types and quantities of equipment from those now listed in their TOEs.

(1) The CSE and light equipment companies have equipment mixes enabling them to undertake survivability missions in the brigade area. This

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[5]DA, USACE, ESC, Engineer Assessment, Europe (U).

CASE II EQUIPMENT-HOUR MIX[a]

Requirement and Capability	D-7 ACE	Loader	Grader	5-Ton Truck	SEE JD410
Requirement:					
SWA	45	16	10	28	1
Europe	41	31	1	27	--
Weighted Average[b]	44	21	7	28	--
Capability:					
TOE Package					
Corps Battalion	26	17	8	26	23
CSE Company	7	7	7	69	3
Weighted Average[c]	20	14	8	40	16
Airborne Battalion	16	16	13	40	5
Light Equipment Company	21	11	16	21	--
Average[d]	19	14	15	31	3

[a]Scrapers are considered, so some totals are less than 100 percent.
[b]SWA = double weight, Europe = single weight.
[c]Two corps battalions plus one CSE Company.
[d]Equal weight; one company and one battalion deploy together.

Figure 22

RECOMMENDED EAD EQUIPMENT CHANGES

Equipment	Change	Unit Affected			
		Corps Bn	CSE Co	Abn Bn	LT Equip Co
Dozer/ACE	Increased	X	X	X	X
Grader	Increased	X			
	Decreased		X[a]		X[a]
Loader	Increased		X		
Dump Trucks:					
20-ton	Decreased		X		
2-1/2-ton	Decreased				X[b]
5-ton	Increased	X	X		X
	Decreased			X	
SEE/JD410	Increased		X[c]		X[c]
	Decreased	X			
Scrapers	Decreased		X	X	X

[a]Decreased to zero; capability maintained in battalions.
[b]Unit design criteria are for C141B transport, so 5-ton dump truck was favored.
[c]Increased to support direct-fire weapon emplacements.

Figure 23

engineer mission was assigned to these two specialized companies, since direct-fire emplacements are time-consuming to dig. Priority also increases when the offense changes to the defense.

ENGINEER EAD RECOMMENDED MISSION CHANGES

Engineer Units	TOE Mission	ESC Recommendation	Implementation
Corps Bn (Wheeled)	Support Corps Reinforce Div	Redistribute Equip	TRADOC Decision
Abn Bn	Reinforce Abn Bn*	Reinforce all LT Div (Abn, Air Assault, LT, & MTZ)	ADEA Accelerate 1 POM Activation
CSE Co	Construction Equip Support	Redistribute Equip for survivability and tank ditching	TRADOC Decision
LT Equip Co	Abn Construction Equip Support	Redistribute equip for survivability	ADEA Accelerate 1 POM Activation

*Construct two medium-lift airfields within 72 hours.

Figure 24

(2) The airborne engineer battalion was used to complete brigade area vital tasks. This shortfall only occurred in the SWA scenario; therefore, this unit was designed only for this theater. One battalion of this type now is in the force structure, designed to support the airborne division. ESC assumed the projected POM increases will be used to support all light forces (air assault, airborne, light, and motorized divisions). These additional units must have equipment that can be transported by C-141B aircraft.

(3) The corps engineer battalion was designed to meet combat engineer missions in the entire corps area. This battalion is combat-

orientated, light for its size, and deployed earlier than CSE companies. For these reasons, the graders in the CSE company were transferred to this battalion. However, the battalion equipment mix and density is not sufficient to match all requirements. The imbalance can be largely offset by assigning one CSE company for every two corps engineer battalions.

14. <u>Division Engineer Battalion Design Proposal.</u>

a. The redesign of the divisional engineer battalion was based on the following criteria:

(1) The squad-to-equipment ratio of requirements was found to approximately equal the same ratio as in the TOE (see Annex I). Consequently no trade offs between squad power and equipment were recommended.

(2) The battalion's design had to meet the demands of the key scenario situations during the MBA delay. In each scenario situation, only vital and critical requirements were considered. (The scenarios were too short to consider the essential and necessary priority tasks which support the longer term sustainability of the division).

(3) The equipment mix of the battalion's current TOE had to be modified to meet the requirements of the scenarios' key situations.

(4) The equipment mix required to meet the division's requirements was different, depending on whether direct-fire weapons were dug in.

b. Figure 25 summarizes the equipment mix recommended for the divisional engineer battalion, based on the requirements indicated by this study's analysis of the key situations in each scenario. The figures reflect the division's operational concept of not digging in any of its direct-fire weapons. Among the major changes recommended in this proposal are:

30

(1) Increasing the number of ACEs assigned to the battalion.

(2) Balancing the 1986 TOE capability between ACEs, 5-ton trucks, and SEEs.

(3) Reducing the number of SEEs and increasing the number of ACEs, depending on the number of positions that must be dug for direct-fire weapons.

KEY SITUATATION EQUIPMENT DISTRIBUTION

Requirement and Capability	Dominant Equipment (Percentage)				
	D7 ACE	Loader	Grader	5-Ton Truck	SEE/ JD410
Key Situation:					
SWA	54	3	--	37	6
Europe	25	9	--	39	27
Direct-Fire Excursion:					
SWA	76	1	--	17	6
Europe	63	4	--	18	15
Capability:					
1986 TOE with					
10 trucks*	35	--	--	19	46
20 trucks*	29	--	--	32	39
ESC Recommended TOE					
(SWA Orientation)	45	--	--	35	20

*LAB and/or MICLIC trailors are parked, freeing 10 or 20 five-ton dropside trucks.

Figure 25

c. Figure 26 shows the recommended TOE equipment mix for the divisional engineer battalion. Twelve SEEs are subtracted from the current TOE, and eight ACEs added. These changes keep the battalion at its present deployment level of 55 C-141B sorties. This recommended design favors the SWA scenario over the European scenario.

REDESIGN OF ENGINEER BATTALION EQUIPMENT

Requirement and Capability	Dominant Unit Equipment			
	ACE	Loader	5-ton Truck	SEE
Key Situation (Percentage):				
SWA	54	3	37	6
Europe	25	9	39	27
Weighted Average[a]	44	5	38	13
Capability:				
1986 Design TOE (Percentage)	29	--	32	39
(Actual quantities)	(18)	--	(20)[b]	(24)
ESC's Recommendation				
Percentage	45	--	35	21[c]
(Actual Quantities)	(26)	--	(20)[b]	(12)

[a]SWA two-thirds and Europe one-third.
[b]Assumes LAB and MICLIC 5-ton drop-side trucks are available.
[c]Percentage increased to offset lack of loaders in units.

Figure 26

15. <u>Bridging Requirements and Capability for Both Scenarios.</u> Site-specific bridge requirements are calculated separately in Annex C and were not included in equipment-hour scenario summaries of paragraphs 11 and 12.

a. The SWA scenario had no small-gap crossing requirements; the European scenario had a peak small-gap requirement during the last 12 hours of the MBA delay. This requirement used all 10 LABs found in the divisional engineer battalion. The SWA scenario had no large-gaps requirement; under the European scenario, there are two river/canal crossings, each of which would need a corps float bridge company to execute successfully. The first crosses a single battalion at the conclusion of the CFA delay; the second, three brigades at the end of the MBA delay.

b. The study scenarios indicate that there are more than sufficient LAB assets in the divisional battalion to satisfy the time-phased requirements. There is also 5-ton truck transport capability available using the LAB prime mover if the LAB trailers are parked when not needed. The opportunity also exists to exchange some LAB trailers for mobility or countermobility equipment that are required for vital and critical tasks. The latter risk can be considered by TOE designers concurrent with adding a small-gap capability to some EAD forces. At present, no engineer EAD unit has a small-gap crossing capability.

16. <u>Class V Supply Requirements for Each Theater</u>. The Class V supply or ammunition requirements were separately examined for the division's countermobility systems, plus the MICLIC, which is used for mobility operations. Results based on both scenarios showed that each theater was supportable within the total tonnage allocated by the sum of the ASRs for the individual systems. The examination revealed that the ASRs of the individual systems were out of balance. It also was concluded that ASRs should be different for SWA and Europe. Additional findings indicated the TEXS is not well suited for the motorized division operations, the divisional engineers' truck assets are marginally acceptable, and more Ground Volcanos are needed.

a. Tank ditches for both scenarios comprise 4 percent of the average obstacle mix. The TEXS tank ditch requires 20 equipment-hours while the nonexplosive (bulldozer or ACE) tank ditch requires 28 hours per kilometer of trench. However, the TEXS also requires 10 more squad-hours and 13.3 tons of explosive per kilometer, which the nonexplosive tank ditch does not require. The squad and logistic demands of the TEXS system limit its use in the severely constrained environment of the two scenarios.

b. Figure 27 shows ESC's recommended ASRs for the seven mobility and countermobility systems analyzed. The new ASRs save tonnage, but do not include AP mines for counterbattery artillery missions. The AP artillery mine ASR can be increased for this mission and still not exceed planned tonnages. The revised rates show:

ENGINEER SYSTEM ASRs

| System | 9ID(MTZ) ASR | ESC's Recommendations | |
		SWA	Europe
MICLIC	10	4	7
Ground Volcano	2,880	3,474	1,930
Air Volcano	1,728	1,256	974
155-mm Artillery			
AT mines	32	41	34
AP mines	24	3	3
MOPMS	110	359	346
M180	120	447	1,009

Figure 27

(1) The AT artillery mine ASR is right for Europe.

(2) The MOPMS and M180 in both theaters and AT artillery mine ASR in SWA are too low.

(3) The MICLIC, Air Volcano, and AP artillery mine ASRs are too high.

(4) The Ground Volcano ASR is too low for SWA and too high for Europe.

c. ESC determined that the twenty-six 5-ton trucks that haul one-half of the MICLIC, LAB, and Ground Volcanos were idle at enough intervals to haul the associated Class V explosives for these systems from BSAs to project

34

sites. (However, no trucks were available for Class IV items like the barbed tape that supplements minefields.) This finding applies equally to both theaters. Overall study findings also disclosed a requirement for work site transport in addition to Class V haul. Engineer EAD support therefore is required to accomplish the majority of truck missions.

d. In determining truck tonnages, ESC was also able to verify mission levels of MICLIC, LAB, and Ground Volcano. This analysis indicated that Volcanos should be increased from six to eight, MICLICs decrease from 10 to eight, and that the average LAB use is six of 10 trailers. These changes allowed six LAB trucks to function purely for internal engineer transport. This realignment was not woven into the TOE redesign, but ESC believes that the division needs two more Ground Volcanos to optimize its rapid linear obstacle capability. The Ground Volcano systems are skid-mounted in the engineer battalion's 5-ton, drop-side trucks. This makes it difficult for the truck to double for hauling Class V explosives. Therefore, all 5-ton trucks within the divisional engineer battalion must be managed intensely.

III. CONCLUSIONS AND RECOMMENDATIONS

17. <u>General.</u> This study reached 12 specific conclusions about the 9ID(MTZ)'s ability to carry out its mobility, countermobility, survivability, and general engineering missions on the battlefield under two very different combat scenarios. Each conclusion is matched by recommendations which follow these practical guidelines:

a. Any changes recommended to the divisional engineer force structure must follow the zero-sum increase rule. The study recommendations do not suggest an increase in the battalion's end-strength or the number of C-141 sorties required to deploy it.

b. Changes must be attainable at low cost. This left some leeway for recommending changes based on long-term development proposals for new types of equipment.

c. ADEA must be able to initiate or influence any action recommended by this study.

18. <u>The 9ID(MTZ) Can Operate Successfully in Undeveloped Areas.</u> The SWA scenario's motorized operations are more demanding for engineers to support than are operations under the European scenario. The SWA AO is much larger than the European AO, covering 8.4 times more terrain. The SWA roadnet also is much less sophisticated, while Europe has many roads, a large percentage of which are paved. Blocking paved roads to impede enemy movement requires a great deal of effort, much of which is beyond the capability of divisional engineers in the European scenario. The SWA AO, however, has few roads, and fewer still paved roads. In many areas, there are no roads at all. Thus, roads do not restrict and concentrate engineer effort from other support missions. This unpaved and sparse roadnet suits the division's unique

capabilities. It matches the division's extensive linear obstacle capability especially well, since the division can rapidly emplace minefields over great distances. This capability is expanded significantly when supplemented by air- and artillery-delivered minefield systems.

a. CONCLUSION: The vital and critical engineering tasks which occur during key situations of the SWA scenario require eight engineer battalions to execute, while it takes six battalions to complete the engineer tasks which occur during the key situations of the European scenario. However, placing eight battalions on the ground in the SWA AO allows the division to cover 41,000 km^2 of terrain. Six battalions give the division influence over only 4,900 km^2 terrain during the European scenario. Therefore, ESC favored the requirements generated by the SWA scenario by 2 to 1 over those generated by the European scenario when weighting the considerations for the division's redesign.

b. RECOMMENDATION: The 9ID(MTZ) engineer battalion should be designed to emphasize the support of contingency operations in undeveloped countries. This would optimize the division's capability to rapidly emplace linear obstacles, and take advantage of its ability to manuever effectively over large areas.

19. The Majority of High-Priority Engineer Requirements Occur at the Phase-Line Worksites. The majority of the tasks in the vital priority group are concentrated in the brigade areas—more than 90 percent are found at the next delay position. The remainder of the high-priority tasks support coun-terattacks. (Counterattack requirements were considered separately, because counterattacks form and dissolve so quickly, and because they many times strike beyond the FEBA.) The divisional engineers can complete up to 50

37

percent of the brigade workload in the vital priority task group (including 100 percent of the tasks required to support counterattacks). When a corps engineer battalion is brought in to augment the division's organic engineers, almost 100 percent of the tasks in the vital priority group can be completed.

a. CONCLUSION: The vital priority workload in the brigade area requires that:

(1) A small but important resource be retained to support counterattacks.

(2) Most of the divisional engineer effort be spent to complete work at the next delay position.

(3) The capability of two engineer battalions be used to meet all vital requirements fully.

b. RECOMMENDATION: The 9ID(MTZ) engineer battalion should be designed to execute vital priority group tasks in the brigade area, while maintaining a full capability to support all counterattacks. This means that:

(1) The equipment mix within the battalion should be adjusted to better meet requirements. ACEs should be increased from 18 to 26 and SEEs should be decreased from 24 to 12 in the 1986 design TOE.

(2) Engineer support for counterattack operations should be provided by the divisional engineer battalion. The peak counterattack requirement under the SWA scenario uses all 18 ACEs of the 1986 design TOE.

(3) In addition to the divisional engineer battalion, at least one EAD engineer battalion should be assigned to the forward brigade area.

20. The Engineers' Most Valuable Resource Is Time. During each scenario, the divisional engineers were deployed with the motorized division over a 14- or 15-day period. The engineers' capability did not peak until all

38

companies arrived. During the same period, requirements (which were averaged over 2 weeks) were relatively low. As a result, the engineers completed most tasks during the 2-week lodgement period. In SWA, the division engineers were able to complete the CFA obstacle plan in 3 days. During the European scenario, the division engineers had only 1.5 days to execute the obstacle plan, and so just completed 38 percent. The European obstacle plan could have been completed if the division had deployed one corps engineer battalion early—but that condition was precluded by the study assumptions. After D-Day, the time covered by either scenario is so short an engineer EAD force has to be used to augment the division engineers if the high-priority requirements are to be met.

a. CONCLUSION: Time is the most important resource engineers can use to support 9ID(MTZ) operations.

b. RECOMMENDATION: Engineer support to the 9ID(MTZ) should be based on:

(1) Deploying the divisional battalion early with the division's brigade (i.e., during lodgement).

(2) Giving the divisional engineer battalion at least 3 days (or, if two battalions are available, 1-1/2 days per battalion) to complete the CFA obstacle plan.

(3) Once the division is engaged in combat operations, an engineer EAD force must be available within the division AO to accomplish vital and critical tasks.

21. EAD Tasks Have Little Impact on the Workload Center. The study's two cases were designed to test the division engineers' capability with and without the added workload imposed by EAD units. However, the EAD workload

was only 3 percent of the SWA scenario-generated requirements, and just 7 percent of the European scenario's requirements (when the EAD workload was combined with the tasks self-generated by the division). The division engineers by themselves could only complete half or less of the divisional workload, so removing the EAD workload had little effect on their performance. If divisional direct-fire emplacements were considered an engineer requirement, the amount of work the division engineers could complete dropped from about 50 percent to 30 percent. And the engineers could meet only 40 percent of the minefield requirement (60 percent if air- and artillery-delivered units were used).

      a. CONCLUSION: The engineer workload is a shared responsibility.

      b. RECOMMENDATION:

      (1) Divisional mining missions should continue to be supported by the combined capability of aviation, artillery, and engineer units.

      (2) Direct-fire emplacements should be predominately a user responsibility. If the operational concept of the division changes to recognize the requirement for direct-fire emplacements, either more time or more EAD units need to be devoted to this mission.

    22. The TEXS or the ACE: Which Should the Divisional Engineers Use? Some 4 percent of the obstacle mix encountered under the SWA and European scenarios requires anti-tank ditches. The divisional engineer battalion can emplace both explosive and nonexplosive tank ditches. The explosive approach uses the TEXS, and requires 11 squad-hours, 20 equipment-hours, and 13.3 tons of explosives per kilometer of trench. The battalion must use its four SEEs (with the trencher attachment) to complement the TEXS. To build a ditch without explosives requires using an ACE and takes 1 squad-hour and 28 equipment-hours per kilometer of trench.

a. CONCLUSION: Explosively prepared tank ditches are more labor-intensive to dig than ditches prepared without explosives.

b. RECOMMENDATION: The divisional engineer battalion should rely on the ACE to provide tank ditching support to the division. The trencher attachments now on four SEEs in the divisional engineer battalion should be replaced to provide the standard SEE equipment configuration. The TEXS and the necessary trenching machines should be retained at the EAD level.

23. The Division's Small-Gap Crossing Capability Varies by Scenario. The division needs small-gap crossing capabilities at key but infrequent points in its operations during the European scenario—10 LABs during the last 12 hours of the MBA delay. This requirement occurs in Northern Germany's open terrain with its many small gaps; fewer small gaps would be encountered during a scenario placed in Southern Europe with its mixed terrain. No small-gap crossing capability is required during the SWA scenario considered by this analysis.

a. CONCLUSION: The division has enough LABs to execute the peak small-gap requirements identified during the SWA and European scenarios. If weighted scenario requirements are used, the divisional LAB assets can be reduced.

b. RECOMMENDATION: Because the division uses its small-gap crossing equipment so infrequently, the 5-ton trucks used to haul LAB trailers should be diverted to material-haul missions whenever possible. LAB assets could be reduced to more equally balance the division's capability to execute engineer missions in the vital task priority group. Planners should also consider adding some small-gap crossing capability to future EAD engineer TOEs.

24. Many Engineer Tasks Only Require Wheeled Mobility Vehicles. The equipment inventory of the divisional engineer battalion has both high-

41

mobility and normal wheeled vehicles. The high-mobility vehicles include the ACE, which is used to support deep strikes at the enemy forward of friendly lines. However, the majority of work at the next delay position or in the DRA is done by EAD engineer units, which rely on normal wheeled mobility vehicles like the 5-ton dump truck. These trucks can use existing roads, have a 10-ton haul capacity, and can travel cross-country under a rated capacity of 5 tons. The CSE company also has a 20-ton dump truck that has very limited off-road capability. Many EAD units plan to convert to higher mobility vehicles in the future.

a. CONCLUSION: Engineers can support most tasks using the wheeled mobility vehicles found in normal equipment inventories.

b. RECOMMENDATION:

(1) Division engineer operations should be planned so LAB and MICLIC trailers can be parked as long as possible; this would free their dedicated 5-ton trucks for internal transportation missions.

(2) Since EAD units can effectively use 5-ton dump trucks and D-7 bulldozers to support motorized operations, these units should rid themselves of 20-ton dump trucks and selectively adopt high-mobility vehicles, such as the HMMWV, the ACE, and the SEE.

25. Adjust Engineer Missions Between Divisional and EAD Engineer TOEs. The motorized division concept identifies high-priority missions and designs the capability for these missions into its structure. Missions of lesser priority are given to follow-on EAD units, and the division accepts the risks the absence or late arrival of these EAD units entail. The study methodology very easily determines the dividing line between the responsibilities of the EAD engineers and those of the division engineers. This adjustment or allocation

42

of duties can be based on priority groups, battle area, and the ability of each engineer resource to accomplish the weighted scenario requirements.

a. CONCLUSION:

(1) The redesigned divisional engineer battalion, to be effective and more successful at completing engineer missions than the existing battalion, must be able to support all counterattack engineer missions. It must be able to complete a significant portion of its vital brigade engineer tasks, and, at the same time, maintain a minimal survivability capability.

(2) EAD engineer units, to effectively reinforce the motorized division while maintaining a capability to reinforce other units, must be able to complete the remainder of the engineer task requirements in the brigade area, surge survivability tasks, and the usual major-gap crossing tasks.

b. RECOMMENDATION: The redesigned divisional engineer battalion should be supported by realigning and adjusting the missions of several EAD units (except the corps engineer battalion, whose mission remains unchanged under this proposal):

(1) The airborne engineer battalion should have its new J-series units designed to support all light forces (airborne, air assault, light, and motorized divisions). This battalion should be evaluated and possibly tested by ADEA for its ability to support motorized and light division operations.

(2) The CSE company should no longer be organized for heavy construction tasks, but rather for forward combat support missions. This unit should be able to execute extensive AT ditching and survivability missions.

(3) The light equipment company (airborne) also should support all light forces; its equipment inventory should include only those items that can be transported by C-141B aircraft. Like the CSE company, its operations should emphasize survivability support combat missions.

43

26. <u>Structure the EAD Force Based on Priority Groups by Theater.</u> To meet the full range of its engineer missions successfully, the 9ID(MTZ) must be supported by engineer EAD forces. The study scenarios were of such a short duration that the tasks in the last two priority groups (essential and necessary) were classed as sustainability missions that could wait a few more days before completion. Therefore, the EAD force requirements for each theater were based only on the requirements generated by the tasks in the vital and critical priority groups.

    a. CONCLUSION: Select EAD force structures by theater using the following four priorities:

        (1) Priority 1--EAD units necessary to complete brigade vital tasks; these units should arrive by D-Day.

        (2) Priority 2--Units needed to complete vital DRA tasks; deploy these units by air.

        (3) Priority 3--Units needed to complete critical brigade tasks; deploy by priority ships.

        (4) Priority 4--Units needed to complete critical DRA tasks; deploy by available ships.

    b. RECOMMENDATION: The 9ID(MTZ) engineer EAD force should contain the following units:

        (1) Priority 1--One corps engineer battalion at D-Day.

        (2) Priority 2--One light corps engineer battalion and one light equipment company for immediate air shipment (SWA theater only).

        (3) Priority 3--One corps engineer battalion (SWA) or one CSE company (Europe) for immediate ocean shipment.

(4) Priority 4--Three additional corps engineer battalions and one (Europe) or two (SWA) additional CSE companies available for ocean shipment.

27. <u>Select EAD Equipment Mix Based on Unit Packages</u>. By weighting scenario requirements 2 to 1 for SWA over Europe, ESC developed a base for determining the appropriate equipment mix for the entire EAD force structure. It would be impractical to design all EAD units with the same equipment mix, since that would give them no flexibility to adjust unit mixes for different threats and theaters. It would be equally difficult to design each unit in isolation. ESC determined from the force structure composition for the motorized division and other Army divisions that certain units complement each other and should be designed together as unit packages.

a. CONCLUSION: Structure an airborne engineer battalion and a light equipment company on a 1-to-1 basis for the SWA scenario, but structure a corps engineer battalion and a CSE company on a 2-to-1 basis for both scenarios.

b. RECOMMENDATION: The equipment in the inventories of all four corps units (airborne engineer battalion, light equipment company, corps engineer battalion, CSE company) should be adjusted by:

(1) Increasing the number of bulldozers (D7 or ACE).

(2) Redistributing the mix of loaders, graders, dump trucks, and SEEs among units.

(3) Eliminating scrapers from all units.

28. <u>Compute New ASRs by Theater</u>. For each scenario, ESC computed the ASRs for the engineer mobility and countermobility systems. These computations produced varying rates for each theater; these rates were different from

those previously proposed by ADEA. However, the total tonnage, of ESC's calculations was lower than ADEA's. This difference can be used for artillery AP mine counterbattery missions, which could not be analyzed within the scope of this study.

a. CONCLUSION: Establish ASRs based on the scenario results of ESC's Class V analysis.

b. RECOMMENDATION: ASRs should be projected based on:

(1) Retaining the existing artillery AT mine ASR for Europe.

(2) Increasing ASRs in both theaters for MOPMS and M-180, and in SWA for artillery AT mines.

(3) Decreasing ASRs in both theaters for MICLIC, Air Volcano, and artillery AP mines.

(4) Increasing the engineer Ground Volcano system for SWA, but decreasing it for Europe.

29. Engineer Battalion 5-Ton Trucks Need Redistribution. ESC's Class V supply analysis determined how much hauling time the division's twenty-six 5-ton trucks had by subtracting the mobility and countermobility requirements of the MICLIC, LAB, and Ground Volcano systems from the overall capability of these 26 trucks.

a. CONCLUSION:

(1) The divisional engineers can support one-half of the job-site truck requirements or one-half of their own Class V supply requirements from the BSA to the job-site.

(2) The divisional engineers have no capability to meet Class IV supply haul requirements.

(3) The distribution of MICLIC, LAB, and Ground Volcano capabilities does not match weighted scenario requirements.

b. Recommendation.

(1) Adjust the mobility and countermobility systems of the divi-
sional engineer battalion to conform to the weighted average of scenario
requirements.

(a) Increase Ground Volcanos from six to eight.

(b) Decrease MICLICs from 10 to eight.

(c) Decrease LABs from 10 to four.

(d) Add six 5-ton trucks with no dedicated mobility or
countermobility system.

(2) Plan to use EAD engineer truck assets to supplement divi-
sional vital tasks and Class V supply haul.

(3) Do not plan to construct wire obstacles unless the construc-
tion effort is augmented by additional trucks.

30. Recommendations Quantified. Using the EFFORT capability model, ESC
can quantify those recommendations that affect the two theater EAD force
structures. This was accomplished by posting all equipment and squad changes
to the eight-battalion SWA and six-battalion Europe force structures. Figure
28 shows these results for the forces before and after the changes recom-
mended. Some notes of explanation:

a. Squad-hour capability exceeds vital and critical requirements
from 10 to 20 percent. This surplus was unavoidable in order to gain 100 per-
cent completion for equipment-hours.

b. Equipment-hour capability decreases 2 to 3 percent for ESC's
recommended equipment levels. This is caused primarily by substituting 5-ton
dump trucks for 20-ton dump trucks in the CSE companies. For each substitu-
tion, equipment-hours are lost but responsive CCM is enhanced. The same

substitution can be seen in the truck column where capability decreases 8 to 9 percent.

RECOMMENDATIONS QUANTIFIED
(Percentages)

Scenario	Workload Completed (Hours)		Equipment Mix					Average Deviation*
	Squad	Equip	ACE	Loader	Grader	Truck	SEE	
SWA (8-Bn Force):								
Requirement	100	100	41	13	8	29	9	--
Existing TOEs	121	103	22	9	9	38	22	9
ESC's Changes	110	100	39	10	7	29	15	2
Europe (6-Bn Force):								
Requirement	100	100	41	17	1	36	5	--
Existing TOEs	122	105	22	8	6	39	25	11
ESC's Changes	110	103	38	9	7	31	15	6

*Difference between existing TOEs or ESC's changes and the requirement averaged for the five pieces of equipment.

Figure 28

c. ESC's changes emphasized improving the equipment mix. ACEs were increased from a 20-percent deficit to within a 2- to 3-percent deficit of the requirement. At the same time, SEEs were decreased but kept at a level sufficient to support survivability tasks or accomplish (at a lower rate) loader requirements.

LAST PAGE OF MAIN PAPER

ANNEX A

STUDY METHODOLOGY

ANNEX A

STUDY METHODOLOGY

1. _Purpose._ This annex describes the significant steps of the study methodology.

2. _Scope._ Figure A-1 shows the general structure and level of resolution of the study methodology. The methodology compares engineer requirements with engineer capability. The requirements are unconstrained, but realistic; they are calculated on-site with no degradation. Capability is degraded with commonly accepted factors such as casualty and movement rates. The comparison of requirements and capabilities produced time-phased estimates on what requirements can be satisfied in priority order.
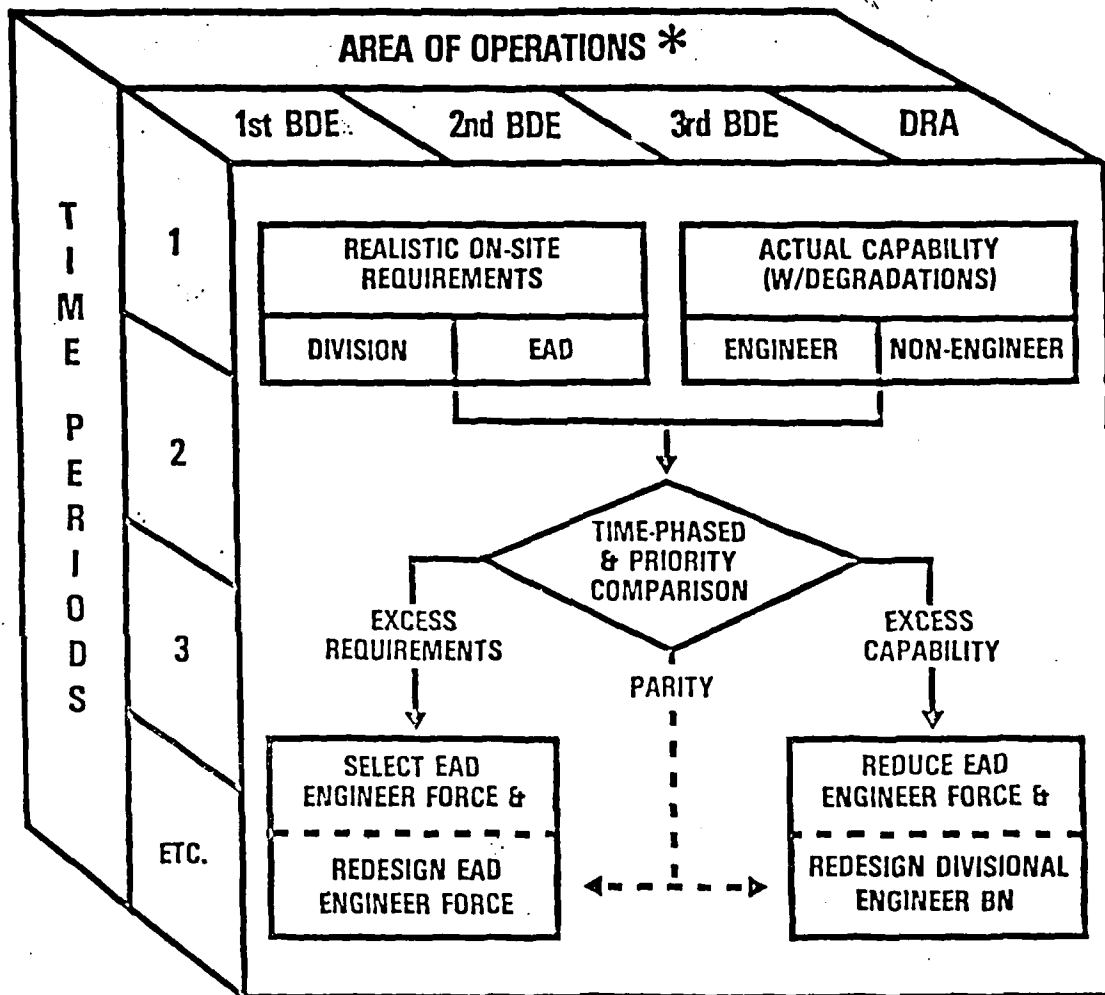
A-1

STUDY METHODOLOGY FOR EACH SCENARIO

*The European scenario has a fifth AO for the CBAA. In this scenario, the CBAA is assigned missions with distinct tactical boundaries.

Figure A-1

A-2

3. <u>Resolution</u>. The study methodology has five main levels of resolution.

    a. The most significant level of resolution calculates into one of two scenarios. (The SWA and European scenarios are detailed in Volume II, which is classified SECRET.)

    b. The second level divides each scenario into battle phases. The battle phases are subdivided into consecutive time periods (Figure A-2).

TIME PERIODS

Period	From	Through	Days	Battle Phase
				SWA Scenario
1	D-18	D-4	15	Deployment, lodgement, and movement to AO
2	D-3	D-1	3	Screening and obstacle operations
3	H-Hour	H+11	1/2	Hasty and deliberate attacks
4	H+12	H+35	1	Delay
5	H+36	H+59	1	Withdrawal and defend
				European Scenario
1	D+29	D+42	14	Deployment, lodgement, and movement to AO
2	H-12	H+11	1	CFA operations
3	H+12	H+35	1	Delay
4	H+36	H+47	1/2	Withdrawal

Figure A-2

    c. The third level addresses the divisional AO. For each time period, requirements and capability are tracked for each of the committed brigades, plus the DRA. The sum of these areas also will be displayed for the total division. (NOTE: When the CBAA does not occupy a separate area, its requirements are counted where subelements are located within the division AO.)

d. The fourth level of resolution divides the study into two cases for each scenario. These cases split capability and requirements between the 9ID(MTZ) only (base case) and EAD units working in the division AO (augmentation case). Figure A-3 lists the EAD units for the scenario augmentation cases. The total deployment strength of these units is between 4,000 and 6,000 individuals. For the augmentation cases, only the post-D-Day periods will be calculated (omitting deployment, lodgement, and pre-D-Day obstacle emplacement periods).

e. The last level tracks engineer capability. Engineer capability will be computed down to company-sized units in squad- and equipment-hours. In addition, engineer equipment in nonengineer units will be evaluated under the category of self-help (e.g., 19 SEEs in DIVARTY). The subdivision of engineer and self-help equipment, combined with the two requirement cases, creates four capability-requirement combinations. Figure A-4 shows these four combinations or cases. Self-help Cases III and IV were looked at subjectively in conjunction with the objective results obtained from the analyses of Case I and II.

4. Requirements. The requirements process must determine what engineer tasks are to be accomplished, how tasks will be grouped, how task calculations will be kept consistent, and how requirements will be ranked.

a. Calculated engineer requirements in the division AO are reduced by any host-nation engineer support that is received. This results in study requirements where only US capability will be applied (if available). This process is documented under the four engineer missions of mobility, counter-mobility, survivability, and general engineering (see Annexes C, D, E, and F, respectively).

EAD AUGMENTATION FOR 9ID(MTZ)

TOE	Description	SWA	Europe
		Quantity	
3-67J	Chemical Company (Smoke)	2	–
3-500H	NBC Team JA	1	–
5-35H	Engineer Battalion (Corps)	1	1
6-401H	Field Artillery Brigade	–	1
6-425H	Field Artillery Battalion (155-mm towed)	2	–
6-445H	Field Artillery Battalion (8-in. self-propelled)	–	3
6-525J	Field Artillery Battalion (MLRS)	1	1
8-123H	Combat Support Hospital	1	–
8-137H	Medical Air Ambulance Company	1	–
8-581H	Evacuation Hospital	1	–
9-62H	Ammunition Battalion HQ and HQ Company	1	–
9-64H	Ammunition Company (DS/GS)	3	1
9-520H	EOD Team FA	1	–
10-67J	Water Supply Company	1	–
10-227H	Petroleum Supply Company	–	1
11-417H	CASC	1	–
11-439H	Forward Radio Company	1	–
12-550H	Postal Detachment Team GC	1	–
19-77H	MP Company	1	–
29-119H	Repair Parts Supply Company		
29-146H	Supply and Service Battalion HQ and HQ Company	1	–
29-147H	Supply and Services Company	1	1
33-500H	PSYOP Company (several teams)	1	–
41-500H	Civil-Military-Cooperation Team (ZC)	–	1
44-245H	ADA Battalion (improved hawk)	1	1
55-16H	Motor Transportation Battalion (one 55-18H610 company)	1	–
55-18H620	Transportation Medium Truck Company (Petroleum)	1	–
55-167J	Platoon Medium Helicopter Company (CH-47)	–	1
55-459H	Transportation Aircraft Maintenance Company	1	–
All	Approximate Deployment Strength	6000	4200

Figure A-3

CAPABILITY AND REQUIREMENT COMBINATIONS

Source of Requirements	Engineer	Self-Help (Nonengineer)
	Capability Source	
Division units	Case I (base)	Case III
EAD units	Case II (augmentation)	Case IV

Figure A-4

b. There are 70 identified tasks (many with additional subtasks) divided among the four engineer missions. For computational ease, these tasks are organized as follows:

(1) The 70 tasks are first compressed into 15 increments. Countermobility has three increments while the other three engineer missions have four increments each.

(2) The 15 increments then are grouped into four priorities: "vital," "critical," "essential," and "necessary." These priority groups served as a framework for judging the relative capability of engineer support. Figure A-5 lists the criteria for each priority group. Vital increments constitute support which is indispensable to the existence and continuance of the division. Critical increments are defined as pivotal support which may be decisive in the success or failure of the division's planned operations. Essential increments are those intrinsic fundamental tasks which must be accomplished, but which are not immediately indispensable. Necessary increments are routine support tasks for which there is a definite need, but which can be deferred for more urgent requirements.

PRIORITY GROUPS

Short Title	Implications of Nonsupport
Vital	Jeopardizes the existence of the division High loss of life Early defeat of the division
Critical	Failure of division operations Increased probability of defeat
Essential	Short-term degradation in sustainability Significant equipment and material losses
Necessary	Long-term degradation in sustainability Moderate equipment and material losses

Figure A-5

(3) The composition of the four priority groups change during the principle battle phases of lodgement, offense, and defense. For each of the three battle phases in each scenario, ESC asked the SAG to place each of the 15 increments into one of the four priority groups. Figures A-6 to A-8 show these three priority lists. The emphasis when using these lists is on planning, not necessarily execution. In reality, all tasks would be carefully integrated based on need and most efficient use of equipment. This need and allocation will change constantly and will only occasionally exactly match the approved priority list. However, it is important to have a basic average priority system that equates to the broader comparison made possible by the four priority groups. In this way, ESC can compare requirements to capability using sums of squad- and equipment-hours of the four priority groups.

c. For estimating squad- and equipment-hours, ESC uses onsite engineer planning factors with no degradations. These unconstrained values are an important part of the analysis:

(1) ESC uses realistic values in reference to the scope of the engineer workload. Any engineer task usually has three levels or standards—optimistic, pessimistic, and realistic or average. Invariably, analysts choose the average standard; ESC's experience indicates it is nonproductive to calculate the other two extremes.

(2) Tasks are unconstrained in reference to condition at the worksite. Most engineer tables and studies are expressed in this way or can be easily converted to this standard. This step of the analysis avoids the common tendency to overestimate a task. Accuracy is regained by degrading capability (also see paragraph 5).

d. In summary, detailed engineer tasks are sequentially combined until arranged for the tactical commander in four priority groups. These

A-7

LODGEMENT PRIORITY LIST

Priority	Level of Support*	Priority Increment**	Condensed Description
1	V	M-1	Reduce obstacles to maneuver elements, repair critical damage to roads and bridges, construct LAPES zones.
2	V	G-1	Repair major LOCs and protect important ammunition and POL sites.
3	V	C-1	Point targets, minefields, and tank ditches on main avenue of approach.
4	V	C-2	Point targets, minefields, and tank ditches on secondary avenue of approach.
5	C	G-3	Repair or maintain tertiary LOCs and repair or protect tertiary facilities.
6	C	M-2	Retrieve and replace tactical bridging.
7	C	G-2	Construct or repair secondary LOCs and important signal sites, and protect important CPs.
8	C	S-1	Protect TOWs, PGATMs, communication nodes, CASCs, and CPs.
9	E	S-2	Protect assault guns, tube artillery, critical I/EW equipment/facilities, TOC equipment, POL forward storage points, and ATPs.
10	E	M-3	Construct combat trails; conduct engineer reconnaissance.
11	E	C-3	Complete obstacle plan.
12	E	S-3	Protect MK-19, radar systems, MLRSs, and FARRPs.
13	N	M-4	Bridging support of river crossings; clear tank ditches and strongpoints; support small-gap crossings; and maintain MSRs and combat trails.
14	N	S-4	Protect Vulcan, Chaparral, Hawk, and mortars.
15	N	G-4	Construct other needed facilities.

*Levels of support: V--Vital, C--Critical, E--Essential, N--Necessary.
**Corresponds to the increment levels in each functional area (e.g., C-1 means countermobility tasks, first increment).
    S--Survivability
    C--Countermobility
    M--Mobility
    G--General Engineering

Figure A-6

A-8

OFFENSE PRIORITY LIST

Priority	Level of Support*	Priority Increment**	Condensed Description
1	V	M-1	Reduce obstacles to maneuver elements; bridging support of river crossings.
2	V	M-2	Repair critical damage to roads and bridges; retrieve and replace tactical bridging; clear tank ditches and strongpoints; support small-gap crossings.
3	V	M-3	Construct combat trails, establish LAPES zones, and conduct engineer reconnaissance.
4	V	G-1	Construct or repair major LOCs and protect important CPs.
5	C	G-2	Repair secondary LOCs and construct and repair secondary facilities.
6	C	C-1	Point targets on main and secondary avenues of approach.
7	C	G-3	Construct and repair tertiary LOCs and tertiary facilities.
8	C	S-2	Protect TOW, PGATM, TOC equipment, POL forward storage points, tube artillery, communication nodes, critical I/EW equipment/facilities, CASC, FARRPs, and ATPs.
9	E	S-1	Protect assault guns, MLRS, and CPs.
10	E	C-2	Minefields and tank ditches on main and secondary avenues of approach.
11	E	C-3	Complete obstacle plan.
12	E	S-3	Protect MK-19, Hawk, and radar systems.
13	N	S-4	Protect Vulcan, Chaparral, and mortars.
14	N	G-4	Construct and repair other needed LOCs and facilities.

*Levels of support: V—Vital, C—Critical, E—Essential, N—Necessary.
**Corresponds to the increment levels in each functional area (e.g., C-1 means countermobility tasks, first increment).
    S—Survivability
    C—Countermobility
    M—Mobility
    G—General Engineering

Figure A-7

DEFENSE PRIORITY LIST

Priority	Level of Support*	Priority Increment**	Condensed Description
1	V	C-1	Point targets, minefields, and tank ditches on main avenue of approach.
2	V	C-2	Point targets, minefields, and tank ditches on secondary avenue of approach.
3	V	C-3	Complete obstacle plan.
4	V	S-1	Protect TOW, PGATM, communication nodes, CASC, critical I/EW equipment/facilities, and CPs.
5	C	G-1	Repair major LOCs and important signal sites, and protect major facilities.
6	C	G-2	Construct and repair secondary LOCs, and protect secondary facilities.
7	C	G-3	Repair tertiary LOCs and construct and repair tertiary facilities
8	C	S-2	Protect assault guns, MK-19, Vulcan, TOC equipment, POL forward storage points, and ATPs.
9	E	S-3	Protect Hawk, radar systems, tube artillery, MLRS, and FARRPs.
10	E	M-3	Construct LAPES zones in DRA and brigade AOs.
11	E	M-1	Bridging support of river crossings, and repair of critical damage to bridges and roads.
12	E	M-2	Breach other obstacles to maneuver; retrieve and replace tactical bridging; construct combat trails; conduct engineer reconnaissance.
13	N	G-4	Construct and repair other needed LOCs and facilities.
14	N	S-4	Protect Chaparral and mortars.
15	N	M-4	Breach minefields; clear tank ditches and strongpoints and provide small-gap crossing support; maintain MSRs and combat trails.

*Levels of support: V--Vital, C--Critical, E--Essential, N--Necessary.
**Corresponds to the increment levels in each functional area (e.g., C-1 means countermobility tasks, first increment).
  S--Survivability
  C--Countermobility
  M--Mobility
  G--General Engineering

Figure A-8

groups are arranged further by battle phase--lodgement, offense, and defense--
for the two scenarios (see Figure A-9). To arrive at unconstrained but
realistic values, the ESC project team analyzed ADEA's operational concept and
then interviewed the 9ID(MTZ) unit and staff representatives at Fort Lewis,
Washington, during the week of 13 November 1984. This data collection trip
also served to validate the scope of engineer tasks and was a principal step
in the study methodology.

ENGINEER BATTLE TASKS AND RANKING

Mission Area	Tasks	Increments	Ranking
Mobility	10	4	Four priority groups: Vital Critical
Countermobility	9	3	Essential Necessary
Survivability	21	4	Ranked for three battle phases: Lodgement Offense
General Engineering	30	4	Defense
Total	70	15	Three priority lists (with four priority groupings per scenario)

Figure A-9

5. Capability. Engineer capability is calculated using the EFFORT
computer model (Annex B). Capability is degraded so when it is compared with
on-site unconstrained requirements, an accurate time-phased assessment is
produced. Four key aspects of EFFORT were used in this study:

a. Measurement elements. The study's calculations were based on the
squad size found in the divisional engineer battalion of the 9ID(MTZ). Five
classes of dominant equipment were also tracked:

A-11

(1) ACE and bulldozer (D7 size).

(2) SEE and tractor with backhoe and loader attachments (JD410).

(3) Front-end loader (2.5 CY).

(4) Grader.

(5) 5-ton truck (cargo or dump) not dedicated to a squad or a mobility/countermobility piece of equipment (i.e., LAB, MICLIC or Ground Volcano).

b. Strength levels. In-theater unit capability is adjusted to represent strengths the Army can realistically field. For this study, the 15th Engineer Battalion of the (9ID(MTZ)) was deployed at 100-percent strength in order to test its forecasted 1986 configuration. Other engineer EAD units were deployed at levels consistent with available manpower. During deployment, all units are subject to enemy air or sea attacks consistent with the scenario assumptions listed in Volume II.

c. Productive time. After arrival in-theater, unit strength is adjusted for casualties and replacements. The workday of individuals also is assessed. Individuals and their equipment are nonproductive while moving, during sleep, providing security, while messing, awaiting equipment repair, etc. These standard and nonstandard degradations were averaged for units; the EFFORT model calculates the remaining daily productivity.

d. Exceptions. EFFORT is not flexible enough to calculate capability for bridge manhours, bridge equipment-hours, and explosive and mine Class V items. Bridging capability (manhours and equipment) is computed separately in Annex C (Mobility); explosive and mine Class V items is computed in Annex D (Countermobility); and Annex G (Class IV/V supply).

6. Comparison Phase. In the final step of the methodology, total division engineer requirements are compared with capability by scenario for

A-12

each time period and AO (Figure A-1). Those results are summed for the whole division and then expressed as averages per day. Figure A-10 shows the principal comparisons made by this analysis.

STUDY CASES

Title/	Engineer Capability		Force Requirements	
Study Section	Division	EAD	Division	EAD
Case I (Base)	X		X	
Case II (Augmentation)	X	X	X	X
Bridging/Mobility	Bridge Surrogates		Bridging	
Mines/Countermobility	Fixed ASRs		Class V	
Mines/Countermobility	GEMSS Surrogates*		Mining	

*No Air Volcano.

Figure A-10

a. Each scenario compared Case I (base) and Case II (augmentation) results. ESC did additional offline Case I and II comparisons for each scenario.

(1) The divisional short-gap bridging requirement was compared to candidate bridge surrogates. ESC conducted this comparison since the organic LAB will not be available until well after 1986. The major-gap requirement for EAD bridge units was also calculated. The methodologies and findings for these comparisons are explained in Annex C (Mobility).

(2) The divisional mine requirement was evaluated and compared to the divisional ASR formulated by ADEA. Engineer mine requirements will be calculated for both the GEMSS and the ground VOLCANO systems. The GEMSS is the Ground Volcano surrogate for the 1986 MTOE of the division. Both this

A-13

Case I mine comparison and the preceding ASR comparison are explained in Annex G (Class IV/V Supply).

b. The expected result of the Case II (augmentation) comparison was an engineer shortfall. Annex G of this document explains the ESC methodology of converting an engineer capability shortfall into an engineer EAD force. If the less likely result of an engineer capability excess had occurred, the engineer EAD force would have been looked at for reductions or relocations.

c. Whether a shortfall existed or not, the 15th Engineer Battalion 9ID(MTZ), was examined for balance by checking the proportion of its capability to corresponding requirement proportions. ESC compared the squad power-to-equipment proportion, as well as the individual equipment mix. For balancing, the battalion's present personnel strength and deployment C-141 sorties were not increased. Changes to the Battalion's TOE were recommended where ESC found the unit out of balance in the same area in both the SWA and European scenarios.

d. Study excursions were planned that diverged from the initial division-only and EAD augmentation case results. These excursions examined a different combination or subset of either requirements or capability, or both. ESC planned five excursions as part of its sensitivity analysis. Annexes H and I explain the basic methodology ESC used for these excursions, along with the scenario findings. The five excursions looked at:

(1) The impact of an attached engineer corps battalion on division capability (Excursion A).

(2) The effect of dividing engineer capability by placing the 15th Engineer Battalion forward (Excursion B).

(3) The influence all other engineer EAD units have on the division's workload in the DRA (Excursion C).

A-14

(4) The impact on capability if only vital and critical tasks are completed (Excursion D).

(5) The effect of digging in direct-fire anti-tank weapons (Excursion E).

e. This study contains one topic that falls outside the main study methodology. ESC analyzed the Class IV and V logistical requirements which must be met to support the division's engineer operations. This analysis used scenario-driven requirements; the methodology is explained in Annex G.

7. *Findings.* Individual annex findings using the stated methodologies were used to develop study conclusions and recommendations. ESC's recommendations pertain to individual scenarios or to both scenarios combined. In moving from conclusions to recommendations, ESC followed these practical guidelines:

a. *Any changes recommended to the divisional engineer force structure must follow the zero-sum increase rule.* The study recommendations do not suggest an increase in the battalion's end-strength or the number of C-141 sorties required to deploy it.

b. *Changes must be attainable at low cost.* This left some leeway for recommending changes based on long-term development proposals for new types of equipment.

c. *ADEA must be able to initiate or influence any action recommended by this study.*

d. *ESC considered ongoing initiatives of the sponsor and the engineer family, and developed ranked decision tables when significant differences warranted.* This allowed all views to be considered, while maintaining ESC's analytical neutrality.

ANNEX B

ENGINEER CAPABILITY

ANNEX B

ENGINEER CAPABILITY

1. <u>Purpose</u>. This annex describes the process used to determine the engineer support capability of the 9ID(MTZ) under an SWA and European scenario. The engineer capabilities of the augmentation forces supporting the 9ID(MTZ) are also identified.

2. <u>Scope</u>. The capability estimates made in this annex reflect the strength of the 9ID(MTZ) as organized under TOE 05-255 D900 (1 December 1984). Estimates were also made for those EAD engineer organizations most prevalent

in the force structure to determine whether the augmentation units can support division requirements.

a. Engineer capability is expressed as net productive manhours or dominant equipment-hours.

b. The EFFORT model was used to calculate the unit strength, movement, battle casualty, and work delay factors used in this analysis.

3. Methodology. Figure B-1 portrays the process developed and used to determine engineer capability on the battlefield. Five steps were followed to compute engineer capability. The following paragraphs explain each step and the analytic variables that impact on capability computations. Figure B-2 is a mathematical sample of the process portrayed in Figure B-1.

a. Step 1: Initial force strength. The first step in calculating engineer capability is to determine the initial force strength.

(1) The starting capability of the initial force (the 15th Engineer Battalion of the 9ID(MTZ)) was based the assumption that it deploys at (ALO)1--i.e., it has 100 percent of its authorized strength. The battalion will deploy and be positioned in the division AO prior to D-Day.

(2) In the SWA scenario, the 39th Engineer Corps Battalion, an active army unit, was gamed to augment engineer capability. The starting capability of this unit was computed based on their authorized strength. In the European scenario, the augmentation force was the 579th Engineer Corps Battalion, a National Guard unit. The starting capability of the National Guard unit was computed based on its actual strength. The National Guard unit was selected because of its late deployment date and the fact that all other active engineer units were previously committed. The two units are identical in capability with the exception of the loaders in the HHC companies'

ENGINEER CAPABILITY MODEL
(MANHOUR AND EQUIPMENT-HOURS)

PRODUCTIVE WORK CAPABILITY

PRODUCTIVE WORK CAPABILITY

PRE D-DAY

D-DAY

BATTLE CASUALTY FACTOR

MOVEMENT & OTHER DEGRADATION FACTORS

WORKDAY LENGTH
MANHOURS & EQUIPMENT-HOURS ★

MINUS OFFSHORE ATTRITION FACTOR

INITIAL FORCE

AIR

SEA

AUGMENTATION FORCE
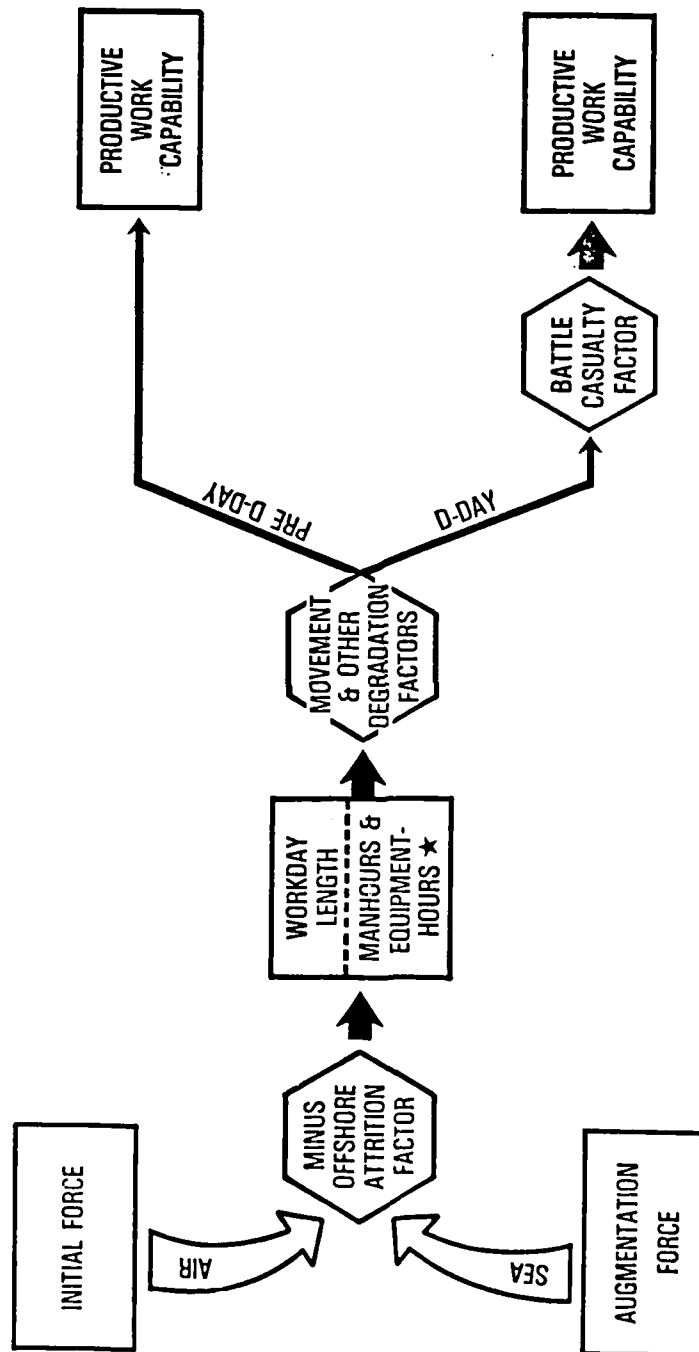
★ EQUIPMENT WORKDAY SHORTENED FOR MALFUNCTIONS

Figure B-1

B-3

SAMPLE ENGINEER CAPABILITY COMPUTATIONS—SWA SCENARIO
(Period 2: D-3 through D-1)

Number of Productive Personnel[a] & Equipment	Air/Sea Attrition[b]		In-Country Force		Work Hours Per Day (Man/Equip)		Number of Days in Period 2		Gross Capability (Hours)		SWA Movement/ Degradation Factor		Productive Work Capability Man-Hours	Squad-Hours
91D(MTZ), A Co														
Personnel:														
49	– 10%	=	44.1	x	18	x	3	=	2381	x	42%	=	1000	143
Equipment:[c]												Equipment Hours	
4 ACEs	– 10%	=	3.6	x	15	x	3	=	180	x	42%	=	76	
6 5-ton trucks	– 10%	=	5.4	x	15	x	3	=	270	x	42%	=	113	
6 SEEs	– 10%	=	5.4	x	15	x	3	=	270	x	42%	=	113	

[a]Productive personnel are those whose skills contribute directly to operations at the work site.
[b]9ID(MTZ) arrives by air, augmentation units by sea. This figure uses a hypothetical number to portray the mathematical computations. Actual numbers are classified.
[c]When computing equipment-hours, the EFFORT model rounds each fraction of a number to the next highest number.

Figure B-2

equipment--the National Guard unit has one loader and the 39th has two. In both scenarios, the corps battalions were assumed in position and effective on D-Day; no deployment times or pre-D-Day capabilities were computed.

b. Step 2: Air-sea attrition factors. Step 2 in estimating engineer capability is to determine and apply air and sea attrition factors to the force strength.

(1) The 15th Engineer Battalion, deploying as part of the initial forces of the 9ID(MTZ), suffers air attrition losses. The percentage of those losses is dictated by the scenario location and date of deployment as presented in the Army Force Planning Data and Assumptions (AFPDA) document.[1]

(2) CONUS augmentation units (i.e., the corps battalions) are attrited for sea losses. The sea lane loss factors used in the EFFORT model are derived from the AFPDA document. The same attrition rates that apply to slow convoys also apply to fast independents.

c. Step 3: Workday length. The third step in the process is estimate the workday length for productive personnel and dominant equipment.

(1) Productive personnel are those people whose skills contribute directly to operations at the work site. Therefore, the contributions of personnel who do mainly "overhead" tasks (e.g., supply clerks, maintenance mechanics, managers) or of those who contribute indirectly to the work site's operations (draftsmen, surveyors, etc.) were not considered by the EFFORT model when calculating squad-hour values.

(a) For this analysis, the 9ID(MTZ) engineer squads are composed of seven productive members. Thus, a squad-hour equates to 7

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[1]DA, OCSA, CAA, Army Force Planning Data and Assumptions, FY 1986-1994 (AFPDA FY 86-94) (U) (hereafter referred to as AFPDA).

manhours. Engineer squads in the augmentation force were assumed to have the same number of productive personnel as the 9ID(MTZ).

(b) The workday length for productive personnel was calculated based on an 18-hour day for the duration of both the SWA and European scenarios.

(2) The dominant items of equipment considered by this analysis were: the ACEs; SEEs; dozers; graders; front-end loaders; JD-410 backhoes; and 5-ton dump or cargo trucks. Trucks used as squad vehicles were not counted as available or productive pieces of equipment. The capabilities of larger items of equipment (e.g., 20-ton dump trucks) were "translated" into items of smaller, but similar capability; thus, one 20-ton dump truck was equivalent to three 5-ton dump trucks.

(3) Before D-Day, some personnel and equipment assigned to a combat mission were considered free for other assignments, and were counted as resources available to enhance the engineer's capability. At the start of combat, however, they resumed their original wartime mission. For example, 5-ton trucks dedicated to pulling LABs or Volcanos could be used for engineering tasks when the towed equipment is parked, but once combat begins, the trucks must revert to their combat mission.

(a) Equipment-hours were calculated based on a 15-hour workday for the SWA scenario and on a 16-hour workday for the European scenario. The shorter workday in the SWA scenario was a function of the theater's less sophisticated road networks, more difficult terrain, and hotter climate, all of which will contribute to a higher rate of equipment malfunctions.

(b) The number of items of dominant equipment is the basis for determining the capability in the equipment-hour category, not the personnel who operate the equipment. For example, the SEE operator is subtracted from the eight-man divisional squad and counted as part of the SEE in the dominant equipment category.

(4) Figure B-2 demonstrates the mathematics of Steps 1 through 3 using a productive in-country strength of 44 persons for Company A of the 9ID(MTZ). This number is multiplied by the number of hours in the workday, then by the number of days in the period. The result is an estimate of the unit's gross capability, in manhours and in dominant equipment-hours.

d. Step 4: Degradation and movement factors. Degradation and movement factors are calculated based on the workday lengths of the scenario under consideration. The productive workday is derived from the unit strength and estimates of the number of productive personnel and items of dominant equipment available. This analysis assumed that engineer units are effective only for those hours after time for travel to the worksite, rest, messing, etc., has been subtracted from the gross available capability. The degradation times used in this analysis were obtained from AR 570-2,[2] as modified by an ESC study.[3]

(1) In both the SWA and European scenario, the available engineer unit workday has been degraded by 25 percent for nonproductive factors commonly encountered, such as security, messing, nondelivery of material, change of mission, and combat disruptions.

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[2]DA, AR 570-2, Organization and Equipment Authorization Tables--Personnel.
    [3]DA, USACE, ESC, Engineer Unit Capabilities (European Environment).

B-7

(2) Because of the size of the division AO and terrain conditions, unit movement accounts for a 33-percent degradation of the workday for engineer units forward of the division rear boundary in the SWA scenario. A 20-percent workday degradation is applied to the European scenario.

(3) The effectiveness factor for personnel and equipment in the SWA scenario is 42 percent (100 - 25 - 33). The European scenario has an effectiveness factor of 55 percent (100 - 25 - 20). Figure B-2 shows the productive work, in manhours and equipment-hours, for one 9ID(MTZ) company in the SWA scenario after applying the 42-percent degradation factor.

e. Step 5: Casualty losses. The final step in computing capability is to apply a battle casualty factor once combat begins at D-Day. Casualties were considered only to the extent that they exceeded replacements. Replacements equal casualties behind the brigade rear boundaries, but casualties exceed replacements forward of those boundaries.

(1) Before any casualty factors can be applied, total engineer casualties for both the SWA and European scenarios had to be determined. This methodology is shown as a mathematical formula in Figure B-3.

(a) Figure B-3 shows how the number of casualties for the maneuver force, total scenario force, and engineers were computed. Figure B-4 lists the maneuver force considered by this analysis (including the infantry, armor, artillery, and cavalry units of the division and the EAD support force). The size of the maneuver force and its attrition :e has a direct cause and effect relationship throughout this methodology. The attrition rate for the maneuver force was derived from the DIME model simulation for SWA and Europe presented in Volume II of this study.

METHODOLOGY FOR DETERMINING CASUALTIES

MANEUVER FORCE CASUALTIES

Maneuver Force[a]		Attrition Rate at end of Model Played[b]		Maneuver Force Casualties
9,400	x	60%	=	5,640

TOTAL BATTLE CASUALTIES

Correlation:				Total
Maneuver Casualties	to	Scenario Casualties		Scenario Casualties
$\dfrac{5,640}{X}$	:	$\dfrac{85}{100}$	=	6,635

ENGINEER CASUALTIES

Total Scenario Casualties		Engineer Attrition Rate		Total Engineer Casualties
6,635	x	3.6%	=	239

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[a]Maneuver force consists of infantry, armor, artillery, and cavalry.
[b]DIME Model.
[c]Based on historical data, the maneuver force sustains 85 percent of all battle casualties.

Figure B-3

MANEUVER FORCE

Maneuver Unit*	Scenario	
	SWA	European
9ID(MTZ)		
5 CAB(H)	2,580	2,580
2 CAB(L)	1,128	1,128
2 LAB	852	852
3 FA Bn (155-mm towed)	1,731	1,731
2 FA Bn (MLRS)	441	441
2 AHB	680	680
1 CAV	493	493
EAD AUGMENTATION		
2 FA Bn (155-mm towed	1,016	0
3 FA Bn (8-inch self-propelled)	0	1,326
1 FA Bn (MLRS)	458	458
Total	9,379	9,689

*The maneuver force is defined as infantry, armor, artillery and cavalry units of the deployed force.

Figure B-4

(b) As shown in Figure B-3, 239 engineer casualties are sustained; that number represents an attrition rate of 3.6 percent. ESC selected the 3.6-rate for this analysis based on the types of units deployed and intensity of combat in the scenario gamed. (Note: the engineer attrition rates used in FM 101-10-1[4] and OMNIBUS-83[5] range from 3.2 percent to 4 percent.)

(2) Engineer casualty rates for each scenario period were developed by analyzing the flow of the battle during each period, the number of casualties sustained by the maneuver force during the corresponding time

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[4]DA, FM 101-10-1, Staff Officers' Field Manual Organizational Technical, and Logistic Data.

[5]DA, OCSA, CAA, OMNIBUS Capability Study--FY 83 (OMNIBUS-83) (U).

period, the amount of engineer work on the various phase lines, and the area lost as the forces retreated. Using these factors, attrition rates were developed for each period and casualties assessed and accumulated until the count equaled 2.39, the total number of engineer casualties expected over the entire scenario. Figure B-5 lists the battle periods of both the SWA and European scenarios and indicates the casualty rate assigned to each period.

BATTLE CASUALTY RATE BY TIME PERIOD

Scenario	Period	Time Frame		Casualty Rate (%)
		From	Through	
SWA	1	D-18	D-4	0.0
	2	D-3	D-1	0.0
	3	H-hour	H+11	3.8
	4	H+12	H+35	7.5
	5	H+36	H+59	13.1
Europe	1	D+29	D+42	0.0
	2	H-hour	H+11	3.8
	3	H+12	H+35	9.3
	4	H+36	H+47	12.9

Figure B-5

(a) SWA engineer alignment and casualties.

<u>1</u>. In the SWA scenario, brigade sectors remain constant throughout the withdrawal phases of the combat periods. Two engineer companies (one each from the 15th and 39th Engineer Battalions) are allocated for the 1st and 3rd brigade sectors. The 2d brigade sector has three engineer companies (one from the 15th and two from the 39th Engineer Battalion). The DRA contains the HHCs of the 15th and 39th Engineer Battalions and D Company of the 15th Engineer Battalion.

<u>2</u>. In Periods 3 and 4 of the SWA scenario (the first 36 hours of combat), the seven forward line companies sustain casualties at the

B-11

rate listed in Figure B-5. The two HHC companies and D company of the 15th Engineer Battalion are not attrited until Period 5, the final 24 hours of combat, when all companies are assessed casualties.

(b) European engineer alignment and casualties.

1. The European scenario, while of short duration, has several boundary and realignment changes for the engineers. Figure B-6 shows the location of the 15th Engineer Battalion and the engineer augmentation force of the 579th Engineer Battalion by time period. Once combat begins, each period is broken down into 12-hour increments to show the movement of the engineer companies to the various brigade sectors or areas of the division AO.

ENGINEER ALIGNMENT WITHIN DIVISION AO (EUROPE)

Period	Time Frame		15th Engr Bn Co					579th Engr Bn Co				
	From	To	A	B	C	D	H&H	A	B	C	D	H&H
1	D+29	D+42	1*	2	3	3	DRA	--	--	--	--	--
2	H-12	H-1	1	2	3	3	DRA	--	--	--	--	--
	H-hour	H+11	1	2	3	3	DRA	1	2	1	2	DRA
3	H+12	H+23	1	2	3	3	DRA	1	2	1	2	DRA
	H+24	H+35	1	2	3	DRA	DRA	1	2	3	CBAA	DRA
4	H+36	H+47	1	2	3	DRA	DRA	1	2	3	CBAA	DRA

*Indicates brigade sector or area within division AO.

Figure B-6

2. In Period 2, the first period of combat, with the forces advancing, only three line companies of the 15th Engineer Battalion receive casualties. In Period 3, seven line companies are assessed casualties for the entire period; D company of the 15th Engineer Battalion is attrited for half the period duration prior to its withdrawal to the DRA. In Period 4,

all companies, including the two HHC companies and D Company in the DRA, are assessed casualties.

(3) Figure B-7 presents a sample of how casualty rates were computed for a single company in the SWA scenario. The top portion of the figure shows the casualty rate with regard to numbers of men or end-strength for each period. The lower section shows available capability by manhours for each period once casualties are assessed. It should be noted that the EFFORT model computes all casualties at the start of each period, rather than at random or at the end of the period.

4. Engineer Force Capability. Figures B-8 and B-9 display the results of EFFORT's calculations of the engineer capability of the 9ID(MTZ), and EAD engineer units under both the SWA and European scenarios. The results are shown by time period and brigade sector in squad-hours and equipment-hours. Comparing the capability of the two scenarios for the 24-hour time period from H+12 through H+35 shows the engineers in the European scenario have about 22 percent more squad-hours and 40 percent more equipment-hours of capability than the same units have under the SWA scenario. The reasons for Europe's significantly greater capability are:

a. A smaller air attrition factor, since units deploy to Europe later than they do under the SWA scenario.

b. A larger productivity factor because of the better road network and less difficult terrain and climate of the European scenario--55 percent versus 42 percent under the SWA scenario.

c. A longer equipment workday--16 hours in Europe and 15 hours in SWA. This longer day accounts for a 7-percent difference in equipment capability.

B-13

SAMPLE CASUALTY COMPUTATIONS--UNIT STRENGTH AND PRODUCTIVE PERSONNEL CAPABILITY

Unit	Air/Sea Attrition Rate* (%)	In-Country Force	Period 3 H-hour through H+11		Period 4 H+12 through H+35		Period 5 H+36 through H+59	
			Casualty Rate (%)	End-Strength	Casualty Rate (%)	End-Strength	Casualty Rate (%)	End-Strength

9ID(MTZ) A Company:

Company Strength

98	10	88	3.8	85	7.5	78	13.1	68

Productive Personnel*

45	10	41	3.8	39	7.5	36	13.1	31

Unit	Air/Sea Attrition Rate* (%)	Productive Work Capability (Manhours)	Period 3 H-hour through H+11		Period 4 H+12 through H+35		Period 5 H+36 through H+59	
			Casualty Rate (%)	Available Capability (Manhours)	Casualty Rate (%)	Available Capability (Manhours)	Casualty Rate (%)	Available Capability (Manhours)

Personnel/Capability

45	10	310**	3.8	149.1	7.5	275.8	13.1	239.7

*Hypothetical number used to portray mathematical computations.
**Computed as 41 personnel working 18 hrs per day for 1 day with an effectiveness factor of 42%.

Figure B-7

SWA CAPABILITY BY TIME PERIOD

Period	Time Frame From	Through	Division Sector	Squad Hours	Equipment-Hours				
					D7/ ACE	Loader	Grader	5-ton Truck	SEE/ JD410
1	D-18	D-4	1st Brigade						
			9ID(MTZ)	770	378	0	0	567	567
			EAD	0	0	0	0	0	0
			2d Brigade						
			9ID(MTZ)	565	277	0	0	416	416
			EAD	0	0	0	0	0	0
			3rd Brigade						
			9ID(MTZ)	359	176	0	0	265	265
			EAD	0	0	0	0	0	0
			DRA						
			9ID(MTZ)	30	38	0	0	50	38
			EAD	0	0	0	0	0	0
			Period Total	1,724	869	0	0	1,298	1,286
2	D-3	D-1	1st Brigade						
			9ID(MTZ)	154	76	0	0	113	113
			EAD	0	0	0	0	0	0
			2d Brigade						
			9ID(MTZ)	154	76	0	0	113	113
			EAD	0	0	0	0	0	0
			3rd Brigade						
			9ID(MTZ)	154	76	0	0	113	113
			EAD	0	0	0	0	0	0
			DRA						
			9ID(MTZ)	88	113	0	0	151	113
			EAD	0	0	0	0	0	0
			Period Total	550	341	0	0	490	452
3	H-hour	H+11	1st Brigade						
			9ID(MTZ)	23	12	0	0	0	18
			EAD	36	9	6	0	9	9
			2d Brigade						
			9ID(MTZ)	23	12	0	0	0	18
			EAD	71	18	12	0	18	18

Figure B-8 (Continued on Next Page)

Period	Time Frame From	Time Frame Through	Division Sector	Squad Hours	Equipment-Hours D7/ ACE	Loader	Grader	5-ton Truck	SEE/ JD410
3	H-Hour (Continued)	H+11	3rd Brigade						
			9ID(MTZ)	23	12	0	0	0	18
			EAD	36	9	6	0	9	9
			DRA						
			9ID(MTZ)	9	19	0	0	0	19
			EAD	8	6	6	12	6	0
			Period Total	229	97	30	12	42	109
4	H+12	H+35	1st Brigade						
			9ID(MTZ)	42	22	0	0	0	34
			EAD	66	16	11	0	16	16
			2d Brigade						
			9ID(MTZ)	42	22	0	0	0	34
			EAD	131	32	22	0	32	32
			3rd Brigade						
			9ID(MTZ)	42	22	0	0	0	34
			EAD	66	16	11	0	16	16
			DRA						
			9ID(MTZ)	18	38	0	0	0	38
			EAD	16	12	12	24	12	0
			Period Total	423	180	56	24	76	204
5	H+36	H+59	1st Brigade						
			9ID(MTZ)	36	19	0	0	0	29
			EAD	57	14	9	0	14	14
			2d Brigade						
			9ID(MTZ)	36	19	0	0	0	29
			EAD	114	28	18	0	28	28
			3rd Brigade						
			9ID(MTZ)	36	19	0	0	0	29
			EAD	57	14	9	0	14	14
			DRA						
			9ID(MTZ)	15	33	0	0	0	33
			EAD	14	10	10	21	10	0
			Period Total	351	146	46	21	66	176

Figure B-8

AD-A162 941   ENGINEER ANALYSIS OF THE 9TH INFANTRY DIVISION   2/4
(MOTORIZED) (91D(MTZ)) VOLUME 1(U) ARMY ENGINEER
STUDIES CENTER FORT BELVOIR VA   D K LEHMANN ET AL.
UNCLASSIFIED   NOV 85 USAESC-R-85-15-VOL-1   F/G 15/5   NL

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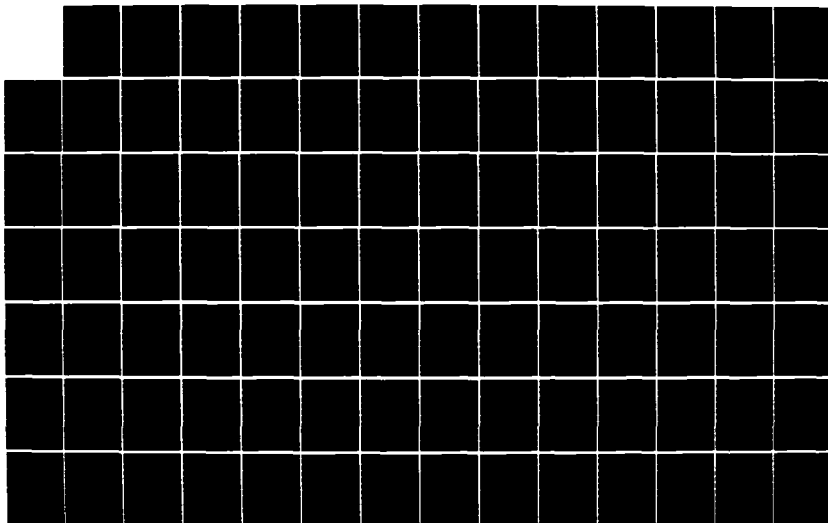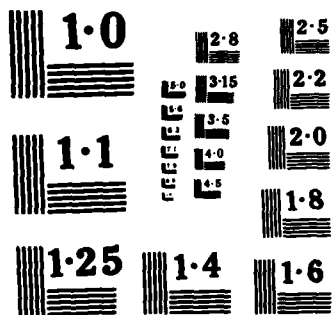
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

EUROPEAN CAPABILITY BY TIME PERIOD

Period	Time Frame From	Time Frame Through	Division Sector	Squad Hours	Equipment-Hours D7/ ACE	Loader	Grader	5-ton Truck	SEE/ JD410
1	D+29	D+42	1st Brigade						
			9ID(MTZ)	960	493	0	0	739	739
			EAD	0	0	0	0	0	0
			2d Brigade						
			9ID(MTZ)	686	352	0	0	528	528
			EAD	0	0	0	0	0	0
			3rd Brigade						
			9ID(MTZ)	647	528	0	0	739	634
			EAD	0	0	0	0	0	0
			DRA						
			9ID(MTZ)	0	0	0	0	0	0
			EAD	0	0	0	0	0	0
			Period Total	2,293	1,373	0	0	2,006	1,901
2	H-12	H+11	1st Brigade						
			9ID(MTZ)	62	35	0	0	0	52
			EAD	101	26	18	0	26	26
			2d Brigade						
			9ID(MTZ)	62	35	0	0	0	52
			EAD	101	26	18	0	26	26
			3rd Brigade						
			9ID(MTZ)	86	88	0	0	0	105
			EAD	0	0	0	0	0	0
			DRA						
			9ID(MTZ)	0	0	0	0	0	0
			EAD	11	9	4	17	9	0
			Period Total	423	219	40	17	61	261

Figure B-9 (Continued on Next Page)

EUROPEAN CAPABILITY BY TIME PERIOD--Continued

	Time Frame		Division	Squad	Equipment-Hours				
					D7/			5-ton	SEE/
Period	From	Through	Sector	Hours	ACE	Loader	Grader	Truck	JD410
3	H+12	H+35	1st Brigade						
			9ID(MTZ)	56	31	0	0	0	47
			EAD	139	36	24	0	36	36
			2d Brigade						
			9ID(MTZ)	56	31	0	0	0	47
			EAD	139	36	24	0	36	36
			3rd Brigade						
			9ID(MTZ)	67	56	0	0	0	72
			EAD	46	12	8	0	12	12
			CBAA						
			9ID(MTZ)	0	0	0	0	0	0
			EAD	46	12	8	0	12	12
			DRA						
			9ID(MTZ)	12	26	0	0	0	26
			EAD	23	18	9	35	18	0
			Period Total	517	258	73	35	114	288
4	H+36	H+47	1st Brigade						
			9ID(MTZ)	24	14	0	0	0	20
			EAD	40	11	7	0	11	11
			2d Brigade						
			9ID(MTZ)	24	14	0	0	0	20
			EAL	40	11	7	0	11	11
			3rd Brigade						
			9ID(MTZ)	24	22	0	0	0	20
			EAD	40	11	7	0	11	11
			CBAA						
			9ID(MTZ)	0	0	0	0	0	0
			EAD	40	11	7	0	11	11
			DRA						
			9ID(MTZ)	10	22	0	0	0	22
			EAD	10	8	4	15	8	0
			Period Total	252	116	32	15	52	126

Figure B-9

5. _Optional Engineer Units Considered._ Although this analysis was primarily directed toward computing the capability of the 9ID(MTZ) with an augmentation force of an engineer corps battalion, other engineer configurations were considered and their capability computed. These were: a corps battalion, a light equipment company, a CSE company, and an airborne battalion. Figures B-10 and B-11 present the capability of these units by squad-hours and equipment-hours for each time period of the SWA and European scenarios. Capability was computed based on their authorized strengths and gamed using the EFFORT model. The units were gamed as arriving and being effective on D-Day. All scenario factors for the base case (the 9ID(MTZ) battalion and augmentation force) were used for these units, with the exception of casualties which were not assessed. Thus, these units were assumed to maintain a constant capability after they arrived in-theater.

6. _Observations._

a. The methodology used for estimating engineer capability under a combat scenario is relatively straightforward. Although ESC used the automated EFFORT model for its calculations, the same methodology can be done manually.

b. Engineer units operating under a European scenario have higher capabilities than those working under an SWA scenario. This difference can be traced directly to values assigned to personnel and equipment productivity factors and to the length of the equipment workday. Figure B-12 displays the productive workhours for one day without casualties.

(1) As shown in Figure B-12, applying the movement degradation percentage (33 percent for SWA versus 20 percent for Europe) results in a productive personnel workday of 7.6 hours in SWA while in Europe the

SWA OPTIONAL ENGINEER UNITS AND CAPABILITY--WITHOUT CASUALTIES

| Time Frame | | Engineer | | Squad | Equipment-Hours | | | | |
From	Through	Unit	TOE	Hours	ACE/ Dozer	Loader	Grader	5-Ton Truck	SEE/ JD410
H-Hour	H+11	Corps Bn	5-35	156	42	27	12	42	36
		LT Equip Co	5-54	0	27	18	54	36	0
		CSE Co	5-58	0	24	30	45	192	9
		Abn Bn	5-195	73	24	30	42	54	12
H+12	H+35	Corps Bn	5-35	311	84	54	24	84	72
		LT Equip Co	5-54	0	54	36	108	72	0
		CSE Co	5-58	0	48	60	90	383	18
		Abn Bn	5-195	147	48	60	84	108	24
H+36	H+59	Corps Bn	5-35	311	84	54	24	84	72
		LT Equip Co	5-54	0	54	36	108	72	0
		CSE Co	5-58	0	48	60	90	383	18
		Abn Bn	5-195	147	48	60	84	108	24

Figure B-10

EUROPEAN OPTIONAL ENGINEER UNITS AND CAPABILITY--WITHOUT CASUALTIES

| Time Frame | | Engineer | | Squad | Equipment-Hours | | | | |
From	Through	Unit	TOE	Hours	ACE/ Dozer	Loader	Grader	5-Ton Truck	SEE/ JD410
H-Hour	H+11	Corps Bn	5-35	213	61	39	17	61	52
		LT Equip Co	5-54	0	39	26	78	52	0
		CSE Co	5-58	0	35	44	65	279	13
		Abn Bn	5-195	100	35	44	61	79	18
H+12	H+35	Corps Bn	5-35	425	122	79	35	122	105
		LT Equip Co	5-54	0	78	52	157	105	0
		CSE Co	5-58	0	70	87	131	558	26
		Abn Bn	5-195	200	70	87	122	157	35
H+36	H+47	Corps Bn	5-35	213	61	39	17	61	52
		LT Equip Co	5-54	0	39	26	78	52	0
		CSE Co	5-58	0	35	44	65	279	13
		Abn Bn	5-195	100	35	44	61	79	18

Figure B-11

productive personnel workday is almost 10 hours—an increase of approximately 30 percent. When casualties are assessed, as in Figures 8 and 9, average scenario productivity for personnel is about 22 percent more in Europe than in SWA.

PRODUCTIVE WORKHOURS PER DAY

	SWA Scenario		European Scenario	
	Personnel	Equipment	Personnel	Equipment
Hours in Day	24.00	24.00	24.00	24.00
Nonwork Time[a]	– 6.00	– 9.00	– 6.00	– 8.00
Work Day	18.00	15.00	18.00	16.00
Nonproductive Time[b]	– 4.50	– 3.75	– 4.50	– 4.00
Work Day	13.50	11.25	13.50	12.00
Movement[c]	– 5.94	– 4.95	– 3.60	– 3.20
PRODUCTIVE WORKHOURS	7.56	6.30	9.90	8.80

[a] Nonwork time includes time for sleep and equipment malfunctions.
[b] Nonproductive time includes time for mess, security, change of mission.
[c] Movement in SWA is 33 percent; in Europe it is 20 percent.

Figure B-12

(2) Figure B-12 also displays the equipment workday: 15 hours in SWA and 16 hours in Europe. This 1-hour increase in the workday accounts for a 7 percent increase in capability. Applying the movement degradation factors yields an equipment workday of 6.3 hours for SWA and 8.8 hours for Europe—a difference of approximately 40 percent. Average equipment capability drops slightly when equipment is attrited during combat but the difference between the SWA and European scenario capability is still significant.

c. Because the movement and workday factors affect the available engineer capability so dramatically, they should be carefully developed and take into account the geographic conditions of the area (scenario) under consideration (e.g., terrain, climate, and transportation network).

LAST PAGE OF ANNEX B

ANNEX C

MOBILITY REQUIREMENTS

ANNEX C

MOBILITY REQUIREMENTS

1. <u>Purpose.</u> This annex identifies and quantifies all of the engineer mobility requirements for supporting the 9ID(MTZ) forward of the brigade rear boundary. The engineer mission area of mobility involves work effort to modify existing terrain conditions so that the planned movement of tactical units is enhanced. Figure C-1 lists the major mobility tasks, grouped into four increments by combat phase.

2. <u>Scope.</u>

a. Requirements calculated in this annex will be limited to mobility tasks in the MBA and CFA during the offensive and defensive phases. Similar requirements which occur behind the brigade rear boundary during these two phases are classified as general engineering effort.

b. The 9ID(MTZ)'s haul capability for Class V items used in executing mobility tasks (i.e., MICLIC) is not addressed in this annex. Annex G will discuss the Class V implications of several mobility tasks.

3. <u>Engineer Mobility Tasks.</u>

a. The Soviet posture will be offensive in nature. Efforts by the motorized division during both the SWA and the European scenario are not sufficient to force the Soviet forces into a defensive setting. Thus, the countermobility effort generated by the Soviets will be limited to minefields installed by the mobile obstacle detachments (POZ) on the flanks of their advancing elements. Were the Soviets compelled to establish either a hasty or deliberate defense, the mobility effort of the motorized division would increase, as it counterattacked through the Soviet defensive belts and its numerous strongpoint defenses.

b. All mobility tasks are assigned a priority increment from M-1 (highest) to M-4 (lowest). The matrix in Figure C-2 depicts the mobility

C-2

MOBILITY PRIORITY INCREMENTS

Phase	Increment	Description
Lodgement	M-1	Breach minefields, tank ditches and other obstacles to manuever elements; repair critical damage to roads and bridges; construct LAPES zones within DRA and Bde AOs.
	M-2	Retrieve and replace tactical bridging with fixed bridging.
	M-3	Construct combat trails; conduct engineer reconnaissance.
	M-4	Bridging support of river crossings; clear tank ditches and strong points; support small gap crossing; and maintain MSRs and combat trails.
Offense	M-1	Breach minefields, tank ditches and other obstacles to manuever plan; bridging support of river crossings.
	M-2	Repair critical damage to roads and bridges; retrieve and replace tactical bridging with fixed bridging; clear tank ditches and strong points; and support small-gap crossing.
	M-3	Construct combat trails; establish LAPES zones in DRA and Bde AOs; and conduct engineer reconnaissance.
Defense	M-1	Bridging support of river crossings; repair critical damage to bridges and roads.
	M-2	Breach other obstacles to manuever; retrieve and replace tactical bridging; construct combat trails; and conduct engineer reconnaissance.
	M-3	Construct LAPES zones in DRA and Bde AOs.
	M-4	Breach minefields; clear tank ditches and strong points; small-gap crossing support; maintain MSRs and combat trails.

Figure C-1

C-3

tasks and indicates which of the tasks are intrinsic to each increment by battle phase. The tasks were ranked from Increment M-1 to Increment M-4 by the SAG.

MOBILITY TASKS AND INCREMENTS

Tasks	Increment Group*			
	M-1	M-2	M-3	M-4
1. Reduction of obstacles				
a. Breach minefield	L,O			D
b. Breach other obstacles to maneuver plan				
(1) Breach tank ditches	L,O	D		
(2) Breach strongpoint	L,O	D		
(3) Breach road craters	L,O	D		
(4) Breach small gaps	L,O	D		
2. Support of river crossing operations	O,D			L
3. Existing roads and bridges				
a. Repair of critical damage	L,D	O		
b. Retrieve/replace tactical bridging		ALL		
c. Maintain MSR and combat trails				L,D
4. Combat trail construction		D	L,O	
5. Reduction of off-road natural obstacles		O		L,D
a. Clear minefields		O		L,D
b. Clear tank ditches		O		L,D
6. Forward aviation combat engineering	L		O,D	
7. Provide information and intelligence		D	L,O	

*L—Lodgement, O—Offense; and D—Defense.

Figure C-2

4. _Methodology_. Figure C-3 shows how ESC determined engineer mobility requirements. For each scenario, ESC developed a set of brigade sectors to support the tactical plan. The scenario chronology and the brigade sectors determined the motorized division and threat postures. Each mobility task then was analyzed for each brigade sector. The friendly posture, threat posture, and terrain analysis determined the number of reinforcing obstacles that must be overcome. The existing obstacles were derived by examining the terrain. Once the total number of obstacles was established, the engineer

C-4

MOBILITY REQUIREMENTS METHODOLOGY

```
                    ┌─────────────────────────┐
                    │     BRIGADE SECTOR       │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │   SCENARIO CHRONOLOGY    │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │   TYPE OF MOBILITY TASK  │
                    └─────────────────────────┘

    ┌──────────────────────┐          ┌──────────────────────┐
    │   FRIENDLY POSTURE    │          │    ENEMY POSTURE      │
    └──────────────────────┘          └──────────────────────┘

    ┌──────────────────────┐
    │  UNIT MOVEMENT RATE   │
    └──────────────────────┘

                    ┌─────────────────────────┐
                    │     TERRAIN ANALYSIS     │
                    └─────────────────────────┘

    ┌──────────────────────┐          ┌──────────────────────┐
    │  EXISTING OBSTACLES   │          │ REINFORCING OBSTACLES │
    └──────────────────────┘          └──────────────────────┘

                ┌───────────────────────────────┐
                │   QUANTIFICATION OF WORKLOAD   │
                │        BY MOBILITY TASK        │
                └───────────────────────────────┘

                ┌───────────────────────────────┐
                │       TOTAL SQUAD-HOURS &      │
                │ EQUIPMENT-HOURS FOR MOBILITY TASK │
                └───────────────────────────────┘
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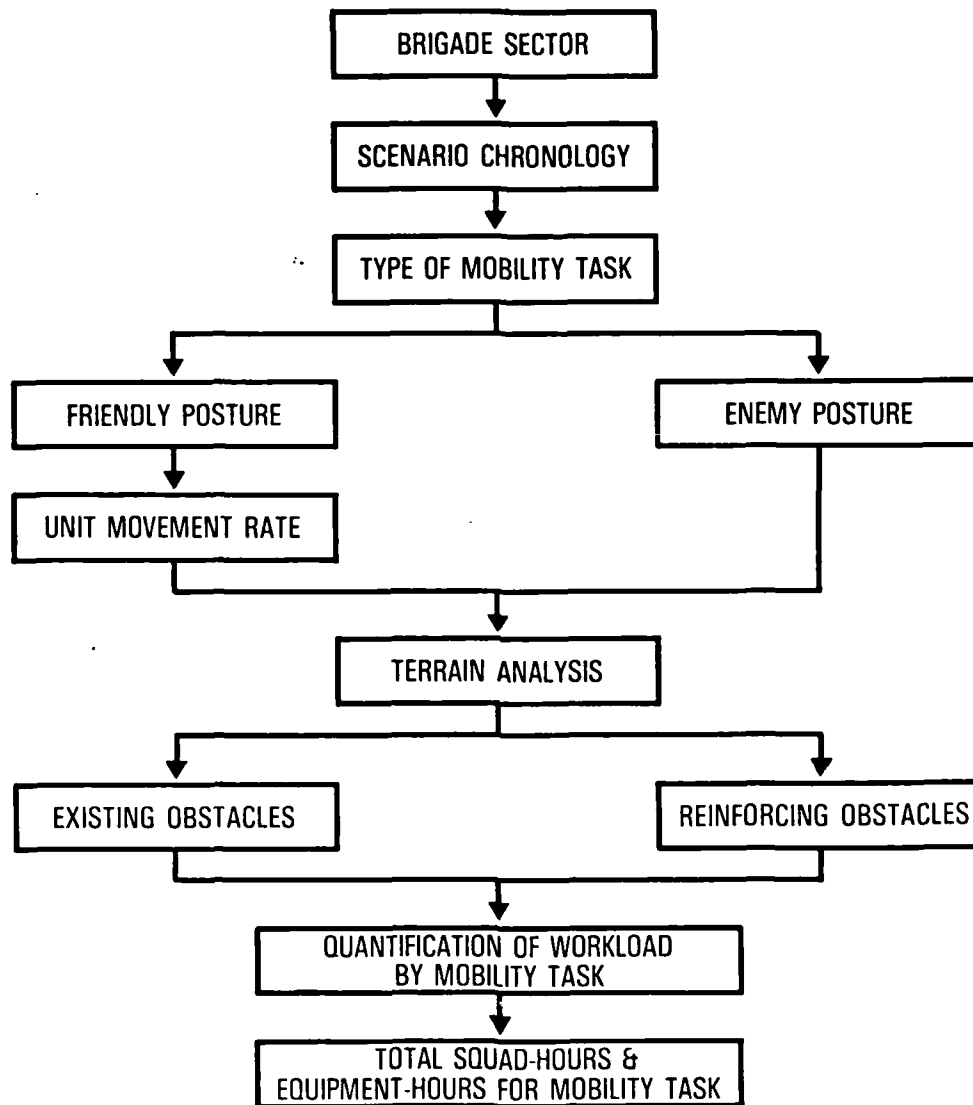
Figure C-3

requirements to support the tasks in each brigade were quantified. The aggregation of the requirements for all the brigades yielded the total squad-hours and dominant equipment-hours required to complete each task in a given scenario and time period.

5. <u>Analysis of Engineer Mobility Tasks</u>. This paragraph describes the mobility tasks of each increment, along with the engineer effort needed by scenario, time period, and brigade sector.

    a. Breach US minefields (Increment M-1).

    (1) The 9ID(MTZ) conducted limited counterattacks in each given scenario. These attacks were characterized by their high mobility, intense firepower, short duration, and rapid egress from the engagement area. Enroute from the starting line to the objective, the division's Combined Arms Battalion could expect to encounter and be required to breach residual US minefields. ESC assumed that only artillery- and aviation-delivered minefields would be breached. Engineer-emplaced minefields will contain gaps and lanes, seeded by MOPMS as the friendly forces pass through. They can be reopened by command-detonating the MOPMS. Of the possible breaches, ESC assumed that only 50 percent need to be executed as a result of bypass, combat neutralization, and failure of the Soviets to reseed. Each assaulting company is assumed to require one vehicle lane. When attacking across open terrain, the approximate distance between lanes is 300 m. Using these two constraints, and the geographical locations of the motorized division's counterattacks superimposed over its defensive minefield belts, the maximum number of minefield breaches that these counterattacks would generate was estimated. Figure C-4 lists the number of breaches by scenario, time period, and brigade.

TOTAL RESIDUAL US MINEFIELD BREACHES

Time Frame			Brigade Sector			
From	Through	Type	1st	2d	3d	CBAA
		SWA Scenario				
D-3	D-1	None				
H-Hour	H+11	Artillery	8	4	0	--
		Aviation	40	21	0	--
H+12	H+35	Artillery	0	0	3	--
		Aviation	0	0	12	--
H+36	H+59	Artillery	10	0	0	--
		Aviation	20	0	0	--
		European Scenario				
H-12	H+11	Artillery	3	0	0	0
		Aviation	8	0	0	0
H+12	H+35	None				
H+36	H+47	Artillery	7	3	0	4
		Aviation	18	9	0	11

Figure C-4

(2) Each artillery-delivered minefield requires 3.1 squad-hours to breach and mark using the MICLIC. The MICLIC, which produces a gap 8 m wide by 100 m deep, can be fired from a 5-ton cargo truck or from its 3/4-ton trailer. Four MICLICs are needed to breach the 400-m depth of an artillery-delivered minefield.

(3) Aviation-delivered minefields require 0.76 squad-hours to breach, using one MICLIC per Air Volcano minefield (60-m depth).

b. Clear US minefields (Increment M-2). Minefields are cleared by removing all mines in a minefield to increase the mobility of follow-on forces. They are cleared after the enemy fires have been eliminated from the mined area. However, the scenario chronologies did not have the 9ID(MTZ) exploit the limited success of its counterattacks. Therefore, no requirement for minefield clearance was generated.

c. Breach threat minefields (Increment M-1).

(1) In the offense, the threat obstacle load is limited to mine-fields emplaced by special teams from regimental and divisional engineers, called mobile obstacle detachments or POZ. These teams are positioned on the flanks of the march column. Their mission is to rapidly lay mines along the most likely enemy avenues for counterattacks. These minefields contain 750 to 1,000 mines per km, and are laid in three belts in a 50-m band.[1]

(2) The threat minefield breaching workload was generated by the counterattack situations arising in each scenario. ESC assumed that each assaulting company required two breaches per minefield, and that the attacking company would encounter one flank minefield per threat battalion assaulted. Figure C-5 shows the number of breaches required by scenario, time period, and brigade. The effort necessary to breach the minefields is 0.76 squad-hours per breach.

TOTAL NUMBER OF THREAT MINEFIELD BREACHES

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	None			
H-Hour	H+11	5	21	0	--
H+12	H+35	0	0	13	--
H+36	H+59	13	0	0	--
European Scenario					
H-12	H+11	6	0	0	0
H+12	H+35	None			
H+36	H+47	6	12	6	6

Figure C-5

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[1]DA, FM 100-2-1, Soviet Army Operations and Tactics.

d. Clear threat minefields (Increment M-2). Neither scenario had a requirement to clear any breached threat minefields in paragraph 4c, since the follow-on forces did not exploit the counterattack successes.

e. Breach tank ditches (Increment M-1).

(1) The 9ID(MTZ) must execute two mobility tasks associated with tank ditches: breaching and clearing. The breaching is done by the combat engineers supporting the manuever forces, so that momentum and the tactical advantage can be retained. Clearing is done by follow-on engineers, widening the original breach to accommodate the less mobile combat support and combat service support units. The breach is an M-1 task—supporting the tactical plan. The clearing is an M-2 task because it is less important to the division. The 9ID(MTZ) could be confronted with two types of tank ditches: residual US ditches and threat ditches. Because of the Soviet's emphasis on flank minefields in the offense, ESC assumed that no significant tank ditch construction would be undertaken by the Soviets. By the same token, it would be reasonable to assume that the Soviets would expend the effort to reinforce residual US tank ditches to their original effectiveness. Therefore, ESC assumed that the requirement for tank ditch breaching was a function of the number of residual US tank ditches encountered during each counterattack.

(2) By overlaying the 9ID(MTZ)'s barrier plan with the proposed attack routes established by the given scenario, ESC estimated the number of tank ditch breaches that must be negotiated by time period and brigade. These data are presented in Figure C-6. It was assumed that one tank ditch breach (8 m wide) could be completed with 0.29 ACE hours of effort. The MOPMS minefield could be command-detonated, if it has not already been neutralized by combat action or self-destruction.

C-9

TOTAL NUMBER OF TANK DITCH BREACHES

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	0	0	0	--
H-hour	H+11	7	18	0	--
H+12	H+35	0	0	12	--
H+36	H+59	8	0	0	--
European Scenario					
H-12	H+11	2	0	0	0
H+12	H+35	0	0	0	0
H+36	H+47	1	2	2	1

Figure C-6

f. Clear tank ditches (Increment M-2). The requirement to clear previously breached tank ditches did not surface in either the SWA or the European scenario, since neither follow-on force exploited the success of the division's counterattacks.

g. Breach strongpoint defenses (Increment M-1). Based on the doctrine concerning the Soviet's posture, ESC assumed that the 9ID(MTZ) would not be faced with the threat strongpoints and defensive belts so characteristic of the Soviet's deliberate defense. The absence of these obstructions meant it was not necessary to breach strongpoint defenses in either the SWA and European scenario.

h. Breach road craters (Increment M-1).

(1) The 9ID(MTZ) is confronted with the two possible mobility tasks--initially breaching a road crater, then clearing the breached road crater. The initial breach is important to maintaining the momentum of the counterattack and the tactical plan, and thus is an M-1 task. Clearing the breached road crater increases the mobility of the follow-on forces, but it is

not as important as the initial breach, and therefore is an M-2 task. The breach will be addressed first.

(2) Due to the Soviet's offensive posture in both scenarios and the short scenario time periods, it was assumed that the Soviets would not construct new road craters, but would most likely reinforce residual US road craters. It was further assumed that 50 percent of the executed US road craters would be negated by combat action, and that 50 percent of the remaining road craters would be bypassed by the highly mobile 9ID(MTZ).

(3) The required road crater breaches was determined by superimposing the 9ID(MTZ)'s barrier plan on the hypothetical counterattack routes established by the given scenarios, and then counting the total number of the road craters encountered. This total was reduced by 75 percent to account for combat neutralization and the division's ability to bypass a portion of the road craters. Figure C-7 lists the number of breaches by scenario, time period, and brigade. ESC determined that 0.25 ACE-hours are required to breach each road crater. The associated MOPMS minefield can be command-detonated, therefore eliminating any requirement to clear the minefield.

TOTAL NUMBER OF ROAD CRATER BREACHES

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	0	0	0	--
H-hour	H+11	11	26	0	--
H+12	H+35	0	0	18	--
H+36	H+59	12	0	0	--
European Scenario					
H-12	H+11	14	0	0	0
H+12	H+35	0	0	0	0
H+36	H+47	5	17	15	10

Figure C-7

(4) The requirement to clear previously breached road craters was insignificant during both the SWA and the European scenarios. Because the follow-on forces did not exploit their counterattacks, there was no need to clear road craters beyond the initial breach.

i. Repair critical damage to bridges (Increment M-1 and M-2).

(1) Damage to bridges in each brigade sector can be attributed to three possible sources—sabotage, aircraft bombing, and artillery damage. The percentage of damage that each source contributes varies with the given scenario.

(a) SWA scenario. Sabotage and aircraft bombs damaged only 0.2 percent of the bridges in SWA scenario, which was determined to be insignificant. Artillery shelling, however, was assumed to inflict damage on 50 percent of all bridges. Of the damaged bridges, 25 percent are difficult to bypass and therefore must be repaired. Since the vast majority of these bridges spanned dry gaps, ESC determined that the construction of a 2-km Class D road was appropriate for circumventing the disabled bridges. The terrain and lack of water obstacles in the SWA scenario favor this approach. Analysis of source documents shows a total of 52 bridges within the three brigade sectors, of which eight will require repair.

(b) European scenario. Two bridges per day are disabled by sabotage during the European scenario, another two bridges are damaged by aircraft bombs throughout the entire division area. Artillery shelling will account for damage to 25 percent of the bridges. Of those disabled bridges, 70 percent are difficult or impossible to bypass, and must be repaired. Analysis of map overlays shows that 30 percent of the 59 bridges in the AO span wet gaps, while the remaining 70 percent span dry gaps. The disabled dry

gap spans were overcome by building a 2-km Class D road. Wet gap spans were repaired by installing Bailey bridge sections. A weighted average of the wet and dry span repair effort was used to determine the overall requirement for engineer effort. The European scenario had the added benefit of HNS, which accounted for 50 percent of the required repair effort. This reduced the US engineer effort required for bridge repair by 50 percent.

(2) ESC prorated the damage and associated repair effort within each brigade based on the number of bridges within a brigade sector during any particular time period and scenario. Figure C-8 shows the number of bridges damaged by scenario, time period, and brigade. Using the repair effort appropriate for each scenario and the data from Figure C-8, ESC determined the total engineer effort required to repair critical damage to bridges by scenario, time period, and brigade.

TOTAL NUMBER OF DAMAGED BRIDGES

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	0	0	0	--
H-hour	H+11	*	*	2	--
H+12	H+35	*	1	1	--
H+36	H+59	2	1	1	--
European Scenario					
H-12	H+11	1	1	2	*
H+12	H+35	1	1	2	*
H+36	H+47	*	*	1	*

*Less than one bridge is damaged.

Figure C-8

(3) The lodgement and defense phases of battle represent 66 percent of the total effort for bridge repair, and have been grouped as an M-1

task. The remaining 34 percent of effort is expended in the offense, which
the SAG ranked as an M-2 task.

j. Repair critical damage to roads (Increment M-1 and M-2). The MSR
net in each brigade area is vulnerable to damage from three sources--sabotage
teams, aircraft ordnance, and artillery and rockets. The entire exposed MSR
net is susceptible to air and sabotage damage, but ESC assumed only that por-
tion of the MSR net within 20 km of the FEBA (the average Soviet artillery
range) would likely sustain artillery damage. The only difference between the
SWA and the European scenarios is the two-fold increase in sabotage damage in
Europe due to the presence of the Spesnatz teams.

(1) ESC's approach to generating the amount of road damage
involved establishing the MSR net by scenario, time period, and by brigade
(Figure C-9). The MSR was also subjected to air and sabotage effects along
its entire length, and to artillery damage within the first 20 km of the
FEBA. Figure C-10 lists the meters of road damaged by time period, scenario,
and brigade.

TOTAL MSR NET
(km)

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	76	56	51	--
H-hour	H+11	34	27	26	--
H+12	H+35	78	64	50	--
H+36	H+59	44	31	62	--
European Scenario					
H-12	H+11	33	30	37	4
H+12	H+35	20	17	18	3
H+36	H+47	11	7	8	0

Figure C-9

C-14

MSR DAMAGE
(meters)

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	152*	112*	102*	--
H-hour	H+11	536	508	504	--
H+12	H+35	712	656	600	--
H+36	H+59	576	524	648	--
European Scenario					
H-12	H+11	598	580	622	104
H+12	H+35	520	442	468	78
H+36	H+47	286	182	208	0

*Sabotage damage only.

Figure C-10

(2) The effort required to repair the road damage is 0.03 ACE-hours per meter of road damage.

(3) The SAG designated the repair of road damage in the defense and lodgement phase to be important to the mobility of the 9ID(MTZ)—an M-1 task. ESC assigned 66 percent of the total effort to this task. Road damage repair in the offense is an M-2 task, receiving the remaining 34 percent of the total effort.

k. Maintain MSRs (Increment M-4). The MSR net for the brigades must be constantly maintained, since it is vulnerable to damage inflicted by aircraft ordnance, artillery and rockets, and sabotage teams. Each kilometer of MSR requires 0.14 squad-hours, 0.25 grader-hours, and 0.25 5-ton truck hours of effort per day. ESC determined the MSR load in km-days for each brigade and for each time period. The amount of MSR net was limited from the BSA forward to the battalion combat trains, which was at least one terrain feature to

the rear of the manuever units. The combat trains were estimated to be within
an average of 5 km of the FEBA. Figure C-11 depicts the total MSR net
requirement by scenario, time period, and brigade sector. When these data are
combined with the MSR work factors, the total requirement by brigade,
scenario, and by time period is generated.

TOTAL MSR NET--MAINTENANCE
(km-days)

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	228	168	178	--
H-hour	H+11	34	27	26	--
H+12	H+35	78	64	50	--
H+36	H+59	44	31	62	--
European Scenario					
H-12	H+11	33	30	37	4
H+12	H+35	20	17	18	3
H+36	H+47	16	6	7	0

Figure C-11

1. FACE (Increment M-3).

(1) FACE operations consist of tasks which provide freedom of
movement for supply, reconnaissance, and tactical aircraft. The spectrum of
engineering effort ranges from clearing and grubbing operations for a forward
airstrip to surfaced runways and protective shelters for an Army or Air Force
operating base in the DRA. The four FACE projects consist of:

(a) Construct helicopter landing zones and FARRPs.

(b) Construct LAPES zones.

(c) Construct fixed-wing landing strips.

(d) Maintain and repair combat damage to forward aviation
facilities.

C-16

(2) Based on interviews with key personnel from the 9ID(MTZ)'s DISCOM, G-3, and manuever brigades, and on the operational concept of the motorized division, ESC determined that of the four tasks listed above, the 9ID(MTZ) had a requirement to support the construction of LAPES zones only. Forward of the brigade rear boundary, the division required one LAPES zone for each brigade adjacent its BSA. Where airfields already existed near BSAs, there was no requirement for a LAPES zone. Movement rearward of the BSAs generated additional requirements for LAPES zones.

(3) The minimum requirement for a LAPES zone is an area approximately 60 ft wide by 800 ft long, free of trees, stumps, and large boulders.

(4) ESC estimated the effort to construct a LAPES zone to be 2.75 ACE-hours. During the European scenario, 1 SEE-hour was also required to cut trees with its hydraulic chain saw attachment. These planning factors became the base case in areas with a CCM of 80 percent or less. ESC then established an inverse relationship to determine the total effort necessary to construct a LAPES zone for areas with a CCM of 81 percent or more. In general, as the CCM increases, the effort to construct a LAPES zone should decrease since an increase in CCM indicates an improvement in the trafficability of the terrain. Figure C-12 depicts this correlation of CCM with required effort. Using the data from the Figure C-12 and the CCM percentages from Annex D, ESC estimated the effort required to construct the LAPES zones (Figure C-13).

m. Construct combat trails (Increments M-2 and M-3). Combat trails are built to provide lateral movement between existing roads and to make it easier for units to move from the road network to unit positions.

LAPES CONSTRUCTION EFFORT

	Effort	
CCM	ACE-hours	SEE-hours
80% and less	2.75	1.00
81% to 90%	1.80	0.70
91% to 99%	0.90	0.30

Figure C-12

REQUIREMENTS TO CONSTRUCT LAPES ZONES

Time Frame		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA
SWA Scenario						
D-3	D-1	None				
H-hour	H+11	ACE	2.75	0	0	--
H+12	H+35	ACE	2.75	1.8	1.8	--
H+36	H+59	None				
European Scenario						
H-12	H+11	ACE	1.8	0.9	0.9	1.8
		SEE	0.7	0.3	0.3	0.7
H+12	H+35	None				
H+36	H+47	ACE	1.8	2.75	1.8	--
		SEE	0.7	1.0	0.7	--

Figure C-13

(1) The following planning factors were used to estimate the engineer effort to construct combat trails for the 9ID(MTZ):

(a) The required length of combat trails constructed daily in each brigade sector is equal to 4 percent of each brigade's width.

(b) The normal engineer effort required to construct each kilometer of combat trail consists of 11 dozer-hours and 12 squad-hours (E-FOSS). This effort has been modified to reflect the nature of the terrain

in both scenarios and the use of the ACE. Figure C-14 lists the effort planning factors developed for each scenario.

ENGINEER EFFORT TO CONSTRUCT COMBAT TRAILS
(1 km)

Scenario	Squad-Hours	ACE D7	SEE
Base (E-FOSS)	12	11	--
SWA	1.7[a]	5.5[b]	--
European	1.72[a]	11.6	0.21[c]

[a]Squad-hours reduced based on limited tree cutting task.
[b]Less stumps and other obstacles to be cleared.
[c]Used for its chain saw attachment.

Figure C-14

(2) Using these planning factors, ESC estimated the engineer effort required for each brigade sector. Combat trails are built during the counterattack phase and the defense phase only. Figure C-15 lists the required number of kilometers of combat trails.

COMBAT TRAIL CONSTRUCTION
(km)

Time Frame		Brigade Sector			
From	Through	1st	2d	3d	CBAA
SWA Scenario					
D-3	D-1	None			
H-hour	H+11	1	1	1.6	--
H+12	H+35	2	2	3.2	--
H+36	H+59	2.3	1.2	2.4	--
European Scenario					
H-12	H+11	0.5	0.6	0.5	0.2
H+12	H+35	0.5	0.6	0.5	0.2
H+36	H+47	0.7	0.5	0.5	0.0

Figure C-15

(3) The effort expended to construct combat trails in the offense phase is considered an M-2 task, while the same effort is an M-3 task in the defense phase.

n. Maintain combat trails (Increment M-4). In both scenarios, the combat trails within the brigade sectors were used for only a short duration, and they carried a traffic load considerably less than that of the MSR. ESC therefore assumed that the engineer effort expended to maintain combat trails would be insignificant.

o. Support of river crossing operations (Increment M-1).

(1) River crossing operations take place in three well-defined phases. Engineer support and requirements are different in each phase. Generally speaking, there are two overriding requirements. First, during the time when friendly forces do not have complete control of the bridgehead, the dispersion and survivability of the force and its crossing means are the predominate concerns. As the security of the crossing area improves, less survivable crossing means can be used. Second, the bridging assets needed to rapidly project the force across rivers are very scarce relative to the other, less capable bridging assets. Therefore, the most tactically capable bridging must be quickly supplemented by other bridging, so that the most rapid crossing means stay forward to support future crossings.

(a) Assault phase. The primary concerns during this phase are establishing control over the bridgehead, survivability of the force, and the need to quickly project combat power over a wide area. Rafting, swimming, and fording are main crossing modes during this phase.

(b) Float bridge phase. Once enemy-observed fires are neutralized, bridge construction commences. Bridges allow greater volumes of

traffic to negotiate the obstacle. Float bridges are employed first because they can be built more rapidly than fixed bridges.

(c) Fixed bridge phase. As soon as the tactical situation permits, float bridges should be supplemented with fixed bridges. This releases the float bridge assets forward.

(2) River crossings are defined as occurring at unfordable gaps which exceed the LAB's capability--23 meters or more. ESC defined and quantified the engineer requirements to support only the wet gap crossings during the assault and float bridge phases of the 9ID(MTZ)'s river crossings. All the bridging or rafting employed in these two phases is assembled by personnel not organic to the divisional engineers. The only asset organic to the motorized division is the ten LABs assigned to the divisional engineer battalion, which are incapable of spanning the gaps under consideration here. The divisional engineers could be expected to help improve access and egress at crossing sites, and establishing ERPs to provide technical vehicle checks and traffic control.

(3) Scenario variations. The analysis of the specific AOs in the SWA scenario revealed no river crossing requirements. This outcome is peculiar to this one geographical location, and is not intended to be expanded into a generalization about the entire political boundary. A river crossing requirement could surface in SWA by merely assigning the 9ID(MTZ) to a sector of responsibilty 100 km removed from its current scenario battleground. On the other hand, the European scenario presents the division with two river crossing situations--the Dortmund-Ems Canal and the Ems River. Both drainage features flow south to north, and bisect the entire division width.

(a) The Dortmund-Ems Canal must be crossed by the covering force units (equivalent of three battalions) in a retrograde action. Although

one fixed bridge per battalion is left intact to accommodate this crossing, a conservative approach must be taken in the event these three sites are denied. Corps float bridge assets would be used to establish three float bridge sites along the Dortmund-Ems Canal. Divisional engineers would provide access and egress along with one ERP per crossing site.

(b) The crossing of the Ems River also would be a retrograde action involving all three brigades on line. FM 90-13[2] states that each brigade in the retrograde requires two heavy raft sites, three assault and swimming sites, and two to three bridges. Many fixed bridges now span the Ems River within each brigade sector, allowing adequate crossing sites for the delaying forces. Assault and swimming sites are not established because of the absence of that capability within the 9ID(MTZ)'s wheeled fleet. Heavy rafting and floating bridging, constructed by corps bridge companies, are required only as a contingency measure in the event enemy action disables all fixed bridging across the Ems River. Due to the width of this water obstacle, rafting is not considered as efficient as float bridging. On the average, a float bridge length of 1-1/2 times that of a heavy raft would span the river. ESC therefore determined that the equivalent of two float bridge sites are required to cross each brigade. To support these crossing sites, divisional engineers must provide access and egress, and one ERP per crossing site.

(4) Based on E-FOSS data, 1.05 ACE-hours are required per crossing site to reduce banks for access and egress, an additional 0.5 SEE-hour to cut trees on or near the banks. ESC assumed two ERPs are required for each crossing site, with five engineers manning the ERP for 12 hours—a total of 17 squad-hours per crossing site. Crossing sites would be chosen to minimize

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[2]DA, FM 90-13, <u>River Crossing Operations</u>.

engineer effort and simultaneously support the tactical plan. Therefore, it was assumed that only 50 percent of the total engineer effort actually is required. Figure C-16 shows a conservative estimate of the number of float bridges and ERPs to support the two river crossings, along with the divisional engineer effort in squad- and equipment-hours required to complete these tasks. The equivalent number of corps bridge companies needed to provide the float bridge assets are also displayed, with only the MAB and Ribbon Bridge companies identified as feasible because of their organic ability to erect and disassemble their respective bridges.

REQUIREMENTS TO SUPPORT RIVER CROSSING OPERATIONS

| Obstacle | Float Bridges | ERPs | Effort (Hours) | | | Corps Bridge Co | |
			Squad	ACE	SEE	5-079*	5-064**
Dortmund-Ems Canal	3	6	26	2	1	0.5	0.5
Ems River	6	12	51	3	2	1	1

*Ribbon Bridge company can provide six 45-meter spans.
**MAB company can provide six 45-meter spans.

Figure C-16

p. Short-gap crossings (Increment M-1). Short gaps are defined as those gaps that are less than 23 m wide—the maximum capability of the division's organic LAB. The division's ability to overcome these short gaps in stride while in the offense affects its probability of maintaining surprise, dispersion, and success in its "hit and run" tactics. The division's high mobility encourages the bypassing of short gap obstacles, but the frequency of short gap occurrence and the nature of the scenario terrain may limit that bypass capability. An analysis of the SWA terrain and surface drainage patterns indicated an insignificant number of short gaps. Those that exist can be bypassed readily, or even negotiated because of their dry state. This

C-23

observation is reserved for a specific geographical location. By moving the 9ID(MTZ) to a more closed area within SWA, the short-gap issue would emerge as significant and worthy of further analysis. The European terrain and drainage patterns, on the other hand, give rise to short-gap obstacles in relatively significant numbers. For that reason, this short-gap discussion is limited to the European scenario.

(1) Assumptions and their significance. ESC based its short-gap methodology on several key assumptions, the denial of any one of which would alter the short-gap bridging requirement.

(a) ASSUMPTION: All gaps less than 23 m are wet gaps. SIGNIFICANCE: The 9ID(MTZ) will encounter dry gaps while moving from the start line to the objective, and many will be bypassed or crossed. The number of dry gaps encountered will reduce the predicted short-gap bridging requirements.

(b) ASSUMPTION: The manuever commander will choose the path, from the start line to the objective, that encounters the fewest wet gaps. SIGNIFICANCE: The tactical situation may drive the battalion commander to select an actual path which has more short gaps than the "ideal" route. Thus, the actual short-gap bridging requirement could be greater than ESC's methodology predicts.

(c) ASSUMPTION: All bridges spanning wet gaps have been disabled. SIGNIFICANCE: The predicted bridging requirement could be reduced by the amount of bridging found still intact.

(d) ASSUMPTION: The entry and exit bank conditions of every short gap are suitable for a 23-m bridge. No other engineer effort is required at a gap site other than emplacing the LAB. SIGNIFICANCE: Less than

C-24

optimal conditions could produce a requirement for additional engineer effort besides that being examined here.

(2) Methodology. ESC's approach was to first develop a total requirement for short-gap bridging as a function of a representative 9ID(MTZ) battalion's movement from the start line to the objective. ESC assumed that the battalion would move within its boundaries from the start line to the objective in such a manner that the number of encounters with short gaps is minimized. The requirement is expressed in the number of 23 m bridges needed, because the LAB is a discrete 23-meter unit and is the main asset used in this type of crossing operation.

(a) A terrain analysis of four representative counterattack areas (one in each brigade sector and the CBAA) was conducted. First, a path was generated within the chosen sector. This path moved from the start line to the objective on a primary or secondary road, while passing over the fewest possible number of short gaps. Next, the number of wet gaps was determined by examining existing drainage patterns. If a gap could be avoided by moving 1.25 km to either side of the path, then a bypass was considered feasible and the gap was not counted. The average 9ID(MTZ) counterattack had a total of 8 km along the path from start line to the objective, and a total of two short gaps to cross. Figure C-17 lists the distance traveled from start line to the objective and the number of gaps encountered for each of the four counter-attacks that were analyzed. Since the last short gap consistently fell within 1.5 km or less of the objective, ESC assumed the final short gap would be recrossed by the assaulting force during its egress from the engagement area, raising the average number of gaps encountered per counterattack to three.

SHORT GAPS--EUROPEAN SCENARIO
(Period 4)

| Typical Counterattack | Brigade Sector | | | | Division |
	1st	2d	3d	CBAA	Average
Distance traveled (km)					
(Start line to objective)	11	6	6	10	8
Total gaps encountered	3	0	1	4	3*

*Average is increased to 3 to account for recrossing the gap closest to objective during egress.

Figure C-17

(b) ESC determined that two LABs per attacking combined arms battalion were required for each short gap encountered (a heavy battalion requires three AVLBs for each short gap). The mobility and "lightness" of the 9ID(MTZ)'s manuever units allowed for employment of fewer bridging assets per gap. Figure C-18 lists the times associated with the emplacement and retrieval of a LAB, and with crossing a LAB by one-half of a CAB. The crossing times were based on a crossing speed of 10 kph and 25-m spacing between vehicles (approximately 0.15 minutes per vehicle). The CAB can cross a short gap using two LABs in 0.16 hours. The LAB, which can be emplaced by its two-man crew in 0.16 hours, is retrieved immediately after the assaulting force has crossed (0.20 hours to retrieve). It then rejoins the manuever force in anticipation of future short-gap missions.

(4) The total requirements for short-gap bridging are listed in Figure C-19 by brigade and time period.

(5) Capability. Applying the productive work time factors for Europe (see Annex B), the 9ID(MTZ) can expect 8.8 productive hours for each LAB per day. Figure C-20 compares the division's LAB requirements with its capability by time period for the European scenario.

LAB--TIME ESTIMATES

Activity	Hours	Total Hours
LAB emplacement	0.16	
LAB retrieval	0.20	
Crossing time-- 1/2 battalion*	0.16	
Total LAB hours per gap for 1/2 battalion		0.52
Total LAB-hours per gap for one battalion**		1.04

*Based on 128 vehicles per battalion.

**Battalion requires two crossing sites.

Figure C-18

TOTAL REQUIREMENTS FOR SHORT-GAPS
(European Scenario)

Time Period			Brigade Sector			
From	Through		1st	2d	3d	CBAA
H-12	H+11	Number of gaps	3	0	0	0
		LAB Hours	3.12	0	0	0
H+12	H+35	None				
H+36	H+47	Number of gaps	3	6	3	3
		LAB Hours	3.12	6.24	3.12	3.12

Figure C-19

LAB ANALYSIS--EUROPEAN SCENARIO

Time Period		LAB Requirement (Hours)	LAB Capability (Hours)	Excess Capability (Hours)
From	Through			
D+29	D+42	NA	NA	NA
H-12	H+11	3	84	81
H+12	H+35	0	79	79
H+36	H+47	16	76	60
Total		19	239	220

Figure C-20

C-27

6. **Results.** The total time-phased requirements for the engineer effort needed to complete 9ID(MTZ) mobility tasks are shown by scenario, brigade, and squad- and dominant equipment-hours for Increment M-1 through M-4 in Figures C-21 through C-24. Since the engineer effort required for river crossing operations and short gaps was calculated manually—not as part of ESC's automated EFFORT model—the associated squad- and equipment-hours are not included in these total time-phased requirements.

ENGINEER MOBILITY REQUIREMENTS
INCREMENT M-1

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA
SWA Scenario						
D-3	D-1	Squad	0	0	0	--
		ACE	5	4	3	--
		5-Ton Truck	0	0	0	--
H-Hour	H+11	Squad	89	115	2	--
		ACE	18	22	14	--
		5-Ton Truck	0	1	3	--
H+12	H+35	Squad	1	1	77	--
		ACE	14	14	21	--
		5-Ton Truck	1	1	2	--
H+36	H+59	Squad	42	1	1	--
		ACE	17	9	13	--
		5-Ton Truck	3	1	1	--
European Scenario						
H-12	H+11	Squad	20	1	7	0
		ACE	15	11	12	2
		5-Ton Truck	1	0	2	0
		SEE	1	0	2	0
H+12	H+35	Squad	2	1	7	0
		ACE	11	11	12	2
		5-Ton Truck	1	0	2	0
		SEE	1	0	2	0
H+36	H+47	Squad	37	22	6	22
		ACE	7	10	10	4
		5-Ton Truck	0.5	0	1	0
		SEE	0.5	0	1	0

Figure C-21

ENGINEER MOBILITY REQUIREMENTS
INCREMENT M-2

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

D-3	D-1	Squad	0	0	0	--
		ACE	3	2	2	--
		5-Ton Truck	0	0	0	--
H-Hour	H+11	Squad	4	4	7	--
		ACE	18	17	26	--
		5-Ton Truck	0	0	2	--
H+12	H+35	Squad	4	4	6	--
		ACE	19	19	25	--
		5-Ton Truck	0	1	1	--
H+36	H+59	Squad	5	3	5	--
		ACE	31	11	21	--
		5-Ton Truck	2	1	0	--

European Scenario

H-12	H+11	Squad	2	1	4	0
		ACE	9	8	9	2
		Grader	0	0	1	0
		5-Ton Truck	0	0	1	0
		SEE	0	0	0	0
H+12	H+35	Squad	1	1	4	0
		ACE	6	6	6	1
		Grader	1	1	1	0
		5-Ton Truck	1	1	1	0
		SEE	0	0	0	0
H+36	H+47	Squad	1	1	2	0
		ACE	6	5	7	1
		Grader	0	0	1	0
		5-Ton Truck	0	0	1	0
		SEE	0	0	0	0

Figure C-22

ENGINEER MOBILITY REQUIREMENTS
INCREMENT M-3

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

From	Through	(Hours)	1st	2d	3d	CBAA
D-3	D-1	Squad	0	0	0	--
		ACE	0	0	0	--
H-Hour	H+11	Squad	1	6	0	--
		ACE	5	15	0	--
H+12	H+35	Squad	0	0	5	--
		ACE	3	2	16	--
H+36	H+59	Squad	4	0	0	--
		ACE	13	0	0	--

European Scenario

From	Through	(Hours)	1st	2d	3d	CBAA
H-12	H+11	Squad	1	1	1	0
		ACE	8	6	5	3
		SEE	1	1	1	1
H+12	H+35	Squad	0	0	0	0
		ACE	2	3	2	0
		SEE	1	1	1	0
H+36	H+47	Squad	1	1	1	0
		ACE	4	5	6	0
		SEE	0	0	0	0

Figure C-23

7. Observations.

a. The MICLIC provides the 9ID(MTZ) with a labor-saving method of breaching minefields. Figure C-25 lists the savings that using the MICLIC creates for the 9ID(MTZ); these range between 1331 and 2073 squad-hours depending on scenario. However, these savings have a price tag attached-- tonnage. The MICLIC is a relatively heavy Class V item. Repeated use may put a burden on the logistical system of the 9ID(MTZ). To the extent that MICLIC resupply becomes logistically impractical, additional engineer effort will be expended to meet the requirements for minefield breaching. Annex G will probe this issue further.

ENGINEER MOBILITY REQUIREMENTS
INCREMENT M-4

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

D-3	D-1	Squad	33	24	25	--
		ACE	60	44	47	--
		5-Ton Truck	60	44	47	--
H-Hour	H+11	Squad	5	4	4	--
		ACE	9	7	7	--
		5-Ton Truck	9	7	7	--
H+12	H+35	Squad	11	9	7	--
		ACE	21	17	14	--
		5-Ton Truck	21	17	14	--
H+36	H+59	Squad	6	4	9	--
		ACE	12	8	17	--
		5-Ton Truck	12	8	17	--

European Scenario

H-12	H+11	Squad	5	4	5	1
		ACE	8	7	9	1
		5-Ton Truck	8	7	9	1
H+12	H+35	Squad	3	2	3	1
		ACE	5	4	4	1
		5-Ton Truck	5	4	4	1
H+36	H+47	Squad	2	1	1	0
		ACE	4	2	2	0
		5-Ton Truck	4	2	2	0

Figure C-24

b. The requirement for short-gap bridging and river crossing support did not surface during the SWA scenario. The short-gap bridging requirement during the European scenario is negligible, with the exception of Period Four when the 9ID(MTZ)'s volume of counterattacks peak the use of the LAB. Despite this, excess LAB capability exists in both theaters. European river crossing support is required in the retrograde; however, in both instances, the crossings are beyond the span capability of the 23-m LAB, and corps bridge company support is required.

MICLIC ANALYSIS

| Time Period | | Total Length of Breach (Meters) | MICLIC (Squad-Hours) | Effort | MICLIC Savings |
From	Through			Conven-tional* (Squad-Hours)	
		SWA Scenario			
H-Hour	H+11	9760	28	1171	1143
H+12	H+35	2570	7	308	301
H+36	H+59	5370	15	644	629
Total					2073
		European Scenario			
H-12	H+11	1980	6	238	232
H+36	H+47	9380	27	1126	1099
Total					1331

*12 Squad-hours per 100 m, using bangalore torpedo and widening breach to 8 m.

Figure C-25

c. US tank ditches and road craters are two of the obstacles emplaced by the 9ID(MTZ) that incorporate a MOPMS minefield. Engineer-emplaced minefields also use MOPMS to close gaps and lanes within the mine-field. A unique characteristic of the MOPMS is its ability to be command-detonated, thus eliminating the need for engineers to neutralize the point minefield when breaching a tank ditch or road crater. This savings of engi-neer effort is quantified in Figure C-26, which lists the number of MOPMS minefields that would require breaching and the associated effort (i.e., using an electronic mine detector and blowing mines in place) by scenario and time period. The savings range from 48 to 78 squad-hours, depending on the scenario.

MOPMS ANALYSIS

Time Period		Total Number of Breaches	Effort* (Squad-Hours)	Savings (Squad-Hours)
From	Through			
SWA Scenario				
H-Hour	H+11	62	43	43
H+12	H+35	30	21	21
H+36	H+59	20	14	14
Total			78	78
European Scenario				
D-12	D+11	16	11	11
D+36	D+47	53	37	37
Total			48	48

*Using mine detector and blowing mines in place--
0.69 squad-hours for 4 m x 10 m area from draft DA, TC 5-101,
Mobility Drills, A 3-10.

Figure C-26

LAST PAGE OF ANNEX C

ANNEX D

COUNTERMOBILITY REQUIREMENTS

ANNEX D

COUNTERMOBILITY REQUIREMENTS

1. Purpose. This annex describes the methodology ESC used to estimate the countermobility requirements of the 9ID(MTZ) under two scenario variations. Countermobility tasks and priorities are identified and compared and the resulting countermobility requirements are summarized.

2. Scope. The scenarios considered by the analysis called mostly for a defensive posture, so ESC's methodology focused mainly on determining the effect of the obstacles listed in Figure D-1 on the 9ID(MTZ)'s countermobility mission. However, each scenario also had a counterattack phase; therefore, the obstacle methodology was modified somewhat to consider the effect of those same classes of obstacles on the forward movement of the division during the offense. This annex will not address the engineer battalion's haul capability for countermobility materials (mines, demolitions, and barrier material). That issue is discussed in Annex G.

COUNTERMOBILITY OBSTACLES

Phase	Increment	Description
Lodgement and Defense	C-1	Point targets, minefields, and tank ditches on main avenue of approach.
Lodgement and Defense	C-2	Point targets, minefields, and tank ditches on secondary avenue of approach.
Offense	C-1	Point targets on main and secondary avenues of approach.
Offense	C-2	Minefields and tank ditches on main and secondary avenues of approach.
ALL	C-3	Completion of obstacle plan.

Figure D-1

3. Assumptions and Their Significance. Several assumptions were made before developing equipment or personnel work factors for the 9ID(MTZ)'s

countermobility mission. All were verified by reviewing current doctrine and by consulting representatives of the 9ID(MTZ) and the staff and instructors at the TRADOC Engineer, Field Artillery, and Aviation schools.

a. ASSUMPTION: The air and artillery scatterable mine systems will be used in addition to the engineer systems to establish linear obstacles in the delay and counterattack phases and to reseed breached minefields. SIGNIFICANCE: This conforms to doctrine for scatterable mine systems. The engineer workload would increase dramatically without air- and artillery-delivered mine systems; proposed barrier plans also would have to be modified substantially.

b. ASSUMPTION: Engineers will move obstacle material from the BSA to the emplacement site. SIGNIFICANCE: Squad and transportation resources, as well as travel time to and from the BSA, were incorporated into the countermobility work factors. Failure of the division transportation and logistical systems to deliver engineer material to the BSA will greatly reduce the number of overall squad-hours that can be expended directly on engineer support tasks and place severe demands on engineer transportation assets.

c. ASSUMPTION: Conventional minefields will not be used. SIGNIFICANCE: The dynamic scatterable mine systems available to the 9ID(MTZ) and short scenario time frame make hand-emplacement of point, tactical, and protective minefields inefficient from both a labor and logistics standpoint. Thus, conventional minefield emplacement was not included as one of this division's engineer tasks. An extended situation would permit use of conventional mine systems by the divisions engineers.

d. ASSUMPTION: Countermobility requirements calculated in this study will be limited to countermobility tasks located forward of the brigade

rear boundary. SIGNIFICANCE: Similar tasks occurring to the rear of the brigade rear boundary are considered general engineering tasks and are discussed in Annex F.

e. ASSUMPTION: *Countermobility requirements defined in this annex are not constrained by stocks of barrier materials and munitions.* SIGNIFICANCE: The logistical support of countermobility tasks is a separate issue which is addressed in Annex G to this report.

f. ASSUMPTION: All tank ditches, wire obstacles, road craters, and abatis are supplemented with MOPMS. SIGNIFICANCE: The total engineer requirement will be less than predicted by this analysis if some of these obstacles are not mined with MOPMS.

4. Definitions.

a. Obstacle density. A factor expressed as the number of obstacle targets per square kilometer in the defensive sector. It is based on terrain features that affect the CCM of enemy formations.

b. Obstacle mix. The mix of point targets (road craters, abatis, and bridge demolitions) and linear targets (minefields, tank ditches, and barbed wire entanglements) (see Figure D-2). Like obstacle density, it is based on terrain features that affect the CCM of enemy formations.

c. Obstacle target priority. The priority of obstacle targets is estimated by considering both the risk expected on the avenues of approach into the defensive sector and the distance of the target from the FEBA.

d. Minefield modules. A planning factor used for scatterable minefields. Conventional minefields are quantified in terms of mines per meter of front. Scatterable minefields, on the other hand, are measured by the number of mines per square meter of area. For planning purposes, it is assumed that

each scatterable mine system will emplace a standard size module. This module is characterized by a specific density and a particular set of dimensions. The module can be adjusted by varying its size and delivery system. For example, the density of the minefield can be increased by decelerating the prime mover to a slower than normal speed, thus increasing the number of mines in a specific area. Each module can be assigned an appropriate measure of effort, reflecting the squad- and equipment-hours required to emplace and mark the minefield module. (Marking is not possible in enemy-held territory, especially when the mines are delivered by air or artillery systems.) Figure D-3 lists the minefield modules considered by this analysis and their characteristics.

OBSTACLE MIX

Posture	Linear Targets (Percentage)	Point Targets (Percentage)
SWA Scenario		
Counterattack	100	--
Delay	96	4
Defend	87	13
European Scenario		
Counterattack	100	--
Delay	85	15
Defend	60	40

Figure D-2

e. Point targets (bridges). Bridges are classified based on their ease of bypass. Those that are impossible or difficult to bypass are

excellent candidates for effective point targets. Engineer work factors were
developed on the basis of bypass conditions, and differ significantly depend-
ing on the scenario's terrain. Engineer effort was not expended on bridges
where the terrain within 1 km of the bridge site allowed easy bypass.

MINEFIELD MODULES

	Size (Meters)	Number of Mines	Density	Time to Place*
ADAM	400 x 400	160 AP (5 rounds)	0.001	0.078 hr**
Air Volcano	1,600 x 60	800 AT 160 AP	0.007	0.033 hr
GEMSS	1,900 x 60	666 AT 133 AP	0.0058	0.5 hr
Ground Volcano	1,600 x 100	800 AT 160 AP	0.005	0.25 hr
MOPMS	35 (semicircle)	17 AT 4 AP	0.0088	0.167 hr
RAAM	400 x 400	800 AT (89 rounds)	0.005	1.39 hr**

*Does not include time for marking minefields.
**Based on sustained fire from one tube.

Figure D-3

5. <u>Task Priority</u>. Since this annex quantifies those 9ID(MTZ) counter-
mobility requirements which must ultimately be measured against limited
engineer resources, ESC developed a system of priority increments for engineer
tasks within all of the engineer functional areas. These priority increments
were used by the SAG to rank all engineer tasks throughout the battlefield.
For the purposes of the analysis described in this annex, three

each scatterable mine system will emplace a standard size module. This module is characterized by a specific density and a particular set of dimensions. The module can be adjusted by varying its size and delivery system. For example, the density of the minefield can be increased by decelerating the prime mover to a slower than normal speed, thus increasing the number of mines in a specific area. Each module can be assigned an appropriate measure of effort, reflecting the squad- and equipment-hours required to emplace and mark the minefield module. (Marking is not possible in enemy-held territory, especially when the mines are delivered by air or artillery systems.) Figure D-3 lists the minefield modules considered by this analysis and their characteristics.

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Defend	87	13
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**Based on sustained fire from one tube.

Figure D-3

5. Task Priority. Since this annex quantifies those 9ID(MTZ) countermobility requirements which must ultimately be measured against limited engineer resources, ESC developed a system of priority increments for engineer tasks within all of the engineer functional areas. These priority increments were used by the SAG to rank all engineer tasks throughout the battlefield. For the purposes of the analysis described in this annex, three

countermobility priority increments were chosen—C-1 through C-3. Priority Increment C-1 contains those engineer countermobility tasks which are most important; Priority Increment C-3 contains the least important tasks. Figure D-4 shows the countermobility increments and the tasks associated with each increment.

COUNTERMOBILITY TASKS AND INCREMENTS

Tasks	Increment Group*		
	C-1	C-2	C-3
1. Install obstacles on main avenue of approach			
Point target	ALL		
Minefield	L,D	O	
Tank ditch	L,D	O	
2. Install obstacles on secondary avenue of approach			
Point target	O	L,D	
Minefield		ALL	
Tank ditch		ALL	
3. Complete obstacle plan			
Point target			ALL
Minefield			ALL
Tank ditch			ALL

*L = lodgement; O = offense; D = defense

Figure D-4

6. Methodology.

a. ESC quantified the 9ID(MTZ)'s engineer requirements in terms of squad-hours and critical equipment-hours by priority increment, by scenario, by time period, and by brigade. Figure D-5 diagrams ESC's methodology for estimating the requirements for engineer countermobility tasks in both the SWA and European scenarios.

COUNTERMOBILITY REQUIREMENTS METHODOLOGY

```
                    ┌─────────────────┐
                    │  BRIGADE SECTOR │
                    └────────┬────────┘
                             ▼
                    ┌─────────────────┐
                    │     TYPE OF     │
                    │COUNTERMOBILITY TASK│
                    └────────┬────────┘
        ┌────────────────────┼────────────────────┐
        ▼                    ▼                     ▼
┌───────────────┐   ┌───────────────┐    ┌───────────────┐
│ POINT TARGET  │   │   MINEFIELD   │    │   TANK DITCH  │
└───────┬───────┘   └───────┬───────┘    └───────┬───────┘
        │                   ▼                    │
        │          ┌─────────────────┐           │
        └─────────▶│SCENARIO CHRONOLOGY│◀─────────┘
                   └────────┬────────┘
                            ▼
                   ┌─────────────────┐
                   │ FRIENDLY POSTURE│
                   └────────┬────────┘
       ┌────────────────────┼────────────────────┐
       ▼                    ▼                     ▼
┌───────────────┐   ┌───────────────┐    ┌───────────────┐
│ COUNTERATTACK │   │     DELAY     │    │     DEFEND    │
└───────┬───────┘   └───────┬───────┘    └───────┬───────┘
        └──────────────────▶│◀───────────────────┘
                            ▼
                   ┌─────────────────┐
                   │ TERRAIN ANALYSIS│
                   └────────┬────────┘
                            ▼
                   ┌─────────────────┐
                   │ NUMBER AND TYPE │
                   │  OF OBSTACLES   │
                   └────────┬────────┘
```

AVIATION DELIVERED (VOLCANO)	ENGINEER WORKLOAD	ARTILLERY-DELIVERED (ADAM/RAAM)

TIME-PHASED QUANTIFICATION OF COUNTERMOBILITY WORKLOAD BY TASK

QUANTIFICATION OF AIR VOLCANO REQUIREMENTS	TOTAL SQUAD-HOURS & EQUIPMENT-HOURS FOR COUNTERMOBILITY TASK	QUANTIFICATION OF ADAM/RAAM REQUIREMENTS

Figure D-5

(1) The scenario chronology generated the friendly postures, against which the nature of the battlefield terrain and its affect on the CCM of each of the division's brigades were analyzed. The CCM percentages (i.e., the percentage of the battlefield on which the enemy force can move relatively freely) are listed in Figure D-6 for the SWA scenario and in Figure D-7 for the European scenario.

CCM PERCENTAGES—SWA SCENARIO*

Area	Brigade Sector		
	1st	2d	3d
Phase Line RED			
1st Delay Area	76	65	61
Phase Line White	60	66	47
2d Delay Area	80	92	97
Phase Line Green	84	96	80
3d Delay Area	62	98	88
Phase Line Amber	66	92	72
4th Delay Area	65	81	81
Final Brigade Rear Boundary			
DRA	--	58	--

*The Soviet BMP was used as the base case.

Figure D-6

(2) Target density factors were developed for a particular range of CCM percentages based on historical obstacle data and recent trends in NATO GDPs. These factors then were modified to account for the mobility and operational concept of the motorized division. Figure D-8 lists the target density factors for each scenario.

CCM PERCENTAGES--EUROPEAN SCENARIO*

Area	Brigade Sector			
	1st	2d	3d	CBAA
CFA	--	--	88	--
Phase Line ALPHA	90	79	76	--
1st Delay Area	93	70	64	--
Phase Line BRAVO	90	66	72	--
2d Delay Area	88	62	80	88
Phase Line CHARLIE	86	72	84	88
3d Delay Area	88	95	93	89
Brigade Rear Boundary	91	89	91	87
4th Delay Area	97	74	88	--
Final Brigade Rear Boundary DRA	--	77	--	--

*The T-62 tank used as the base case.

Figure D-7

(3) Equation D-1 was used to calculate the obstacle workload in each brigade area:

[Eq D-1]

(obstacle mix) x (target density) x (square kilometers of area)
= the number and type of obstacles for each brigade subarea.

This workload was then subdivided by delivery means: aviation, field artillery, and engineer emplacement.

OBSTACLE DENSITY
(Obstacles/km^2)

CCM Factor*	Heavy Division Europe	9ID(MTZ) SWA	9ID(MTZ) Europe
0.00-0.29	0.67	0.40	0.50
0.30-0.44	1.00	0.60	0.75
0.45-0.54	1.33	0.80	1.00
0.55-0.69	1.67	1.00	1.25
0.70-0.77	2.00	1.20	1.50
0.78-0.82	2.33	1.40	1.75
0.83-0.88	2.67	1.60	2.00
0.89-0.93	3.00	1.80	2.25
0.94-1.00	3.33	2.00	2.50

*Derived from analysis of the World War II European Campaign and current NATO GDPs.

Figure D-8

(4) The squad- and equipment-hours were calculated for every engineer-emplaced obstacle. Minefield module requirements were tracked for air- and artillery-delivered obstacles, but not considered in the calculation of engineer requirements. Figure D-9 shows the effort in squad- and equipment-hours required to emplace linear obstacles and point obstacles. Figure D-10 lists the composition of each target, as a percentage, by posture, scenario, and obstacle system.

(5) By using the algorithm in Figure D-11 and the data from Figures D-8 through D-10, the engineer countermobility effort necessary to support the 9ID(MTZ) in both the SWA and European scenarios was quantified.

COUNTERMOBILITY PLANNING FACTORS

Obstacle/System	Squad-Hours	Equipment-Hours 5-Ton	ACE	SEE
Ground Volcano (1 module)[a]	1.93	--	--	--
GEMSS (1 module)[b]	2.43	--	--	--
Tank Ditch (500 m)[c]	--	1.72	14.07	--
Road Crater (NORTHAG)[a,c,d]	0.57	1.10	--	0.95
(SWA)	0.56	0.50	--	0.30
Wire (300 m)[d]	5.85	3.75	--	--
Bridges (pre-chambered)[e]	0.64	0.56	--	--
(non-chambered)[e]	3.10	2.20	--	--
Abatis (75 m)[c]	0.89	1.05	--	0.40

[a]ESC estimate.
[b]USAES, FC 5-102.
[c]DA, USACE, ESC, Combat Engineering Tasks (Manpower and Equipment Estimates (from Engineer Family of Systems Study (E-FOSS)).
[d]DA, USACE, ESC, Middle East Target Analysis.
[e]DA, FM 5-102, Countermobility.

Figure D-9

SYSTEM TARGETS
(Percentages)

Obstacle System	Friendly Posture Counterattack SWA	Europe	Delay SWA	Europe	Defend SWA	Europe
Air Volcano	22%	22%	24%	21%	NA	NA
Ground Volcano	NA	NA	20%	17%	58%	39%
ADAM/RAAM	78%	78%	42%	37%	NA	NA
GEMSS	NA	NA	8%	7%	22%	15%
Tank Ditch	NA	NA	2%	2%	7%	4%
Road Crater	NA	NA	4%	13%	13%	38%
Abatis	NA	NA	NA	2%	NA	2%
Wire	NA	NA	*	1%	*	2%
Totals	100%	100%	100%	100%	100%	100%

*Less than 1%.

Figure D-10

COUNTERMOBILITY REQUIREMENTS ALGORITHM

Engineer Requirements (Hours/Type of Obstacle) =

| Area (km^2) | X | Target Density (Obstacle/km^2) (See Figure D-8) | | Target Mix (% of Type Obstacle)* (See Figure D-10) | X | Resource Requirements (Squad-Hours & Equipment-Hours/Type) (See Figure D-9) |

$$\text{Area (km}^2) \times \text{Target Density (Obstacle/km}^2) \times \text{Target Mix (\% of Type Obstacle)*} \times \text{Resource Requirements (Squad-Hours \& Equipment-Hours/Type)}$$

---

*Mix depends on friendly posture.

Figure D-11

b. Counterattacks. The counterattacks that occurred in both scenarios were classified into four general categories: ground manuever units only (Category 1); ground forces with attack helicopter support (Category 2); attack helicopter only (Category 3); and TACAIR only (Category 4). Because of the dynamic situation inherent in counterattacks and ESC's interpretation of the doctrine given in FM 5-102, Countermobility, no engineer countermobility effort was expended to support any category of counterattack.

(1) Categories 1 and 2 counterattacks used three RAAM artillery modules per counterattack to disrupt movement and prevent the commitment of threat second echelon forces, and one aviation module (Air Volcano) per counterattack to deny the enemy unrestricted use of terrain and reduce his capability to flee the engagement area.

(2) The Category 3 counterattacks required one Air Volcano module sited to the front of the oncoming threat force. The minefield was covered by fire from attack helicopters armed with antitank weapon systems. Category 1 through 3 counterattacks were concluded with a volley of artillery-delivered anti-personnel mines (ADAM).

(3) Category 4 counterattacks required no Army countermobility support. The Air Force delivered mine systems were not quantified in this methodology.

c. Defend. ESC developed a separate methodology to estimate countermobility requirements when the 9ID(MTZ) was in the defensive posture.

(1) The depth of the defensive belt ESC established along each phase line was a function of the maximum effective ranges of the anti-armor weapons systems used in both scenarios and the average distance between successive US battle positions. Within these defensive belts, obstacles were executed along likely enemy avenues of approach. The width of each avenue corresponded to a weighted average of Soviet Regimental frontages when in the offensive, and the width of the brigade sectors. The brigade sectors in the SWA scenario were three times as wide as those established for the 9ID(MTZ) in the European scenario.

(2) Figure D-12 compares the methodology's countermobility parameters for the SWA scenario to those of the European scenario. Since the engineers are working at least one barrier system to the rear of the FEBA, care must be exercised when seeding scatterable minefields close to friendly troops. Therefore, requirements were calculated for engineer effort only when engineers were constructing obstacles in the phase line defensive belts.

d. Delay. The 9ID(MTZ) expends most of its resources executing a delaying mission during both scenarios. ESC developed a unique methodology to estimate the countermobility requirements during this friendly posture. Requirements were generated along the likely enemy avenues of approach in each brigade sector, but were limited to the area between phase line defensive belts. The major difference between ESC's defend and delay methodologies was in the target mix (see Figure D-10). The delay methodology should be more

dynamic and reactive to the actions taken by the Soviet forces, and therefore quick-response obstacle delivery systems (aviation and artillery) should supplement the engineer-emplaced obstacles. The defend methodology relied solely on engineer effort, while the delay methodology allowed the use of the Air Volcano and ADAM/RAAM.

SCENARIO VARIATIONS*

Parameter	SWA (km)	Europe (km)
Average width of enemy avenue of approach	8	6-7*
Average width of brigade sector	50	17
Average distance to successive battle position	10	6
Number of likely avenues of approach	7	5
Depth of phase line defensive belt	13	7

*Varies with width of brigade sector.

Figure D-12

7. Results. The total time-phased requirements for the engineer squad and equipment effort needed to undertake 9ID(MTZ) countermobility tasks are shown by scenario, brigade area, and priority increment in Figures D-13 through D-15. The number of minefield modules, road craters, bridge demolitions, abatis, and meters of tank ditches and wire obstacles required by scenario, time period, and brigade area are listed in Figures D-16 through D-18.

8. Observations.

a. Minefield emplacement.

(1) Figure D-19 shows the allocation of minefields by delivery systems for both the SWA and European scenarios. Of the total minefield

D-15

COUNTERMOBILITY REQUIREMENTS
INCREMENT C-1

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

D-18	D-4	None				
D-3	D-1	Squad	7	11	18	--
		ACE	6	10	7	--
		5-Ton Truck	10	9	14	--
		SEE	1	2	1	--
H-Hour	H+11	Squad	71	98	67	--
		ACE	70	97	65	--
		5-Ton Truck	85	87	60	--
		SEE	13	20	12	--
H+12	H+35	Squad	26	117	54	--
		ACE	25	51	51	--
		5-Ton Truck	20	105	42	--
		SEE	5	10	10	--
H+36	H+59	Squad	6	3	2	--
		ACE	0	0	0	--
		5-Ton Truck	4	2	1	--
		SEE	0	0	0	--

European Scenario

D+29	D+42	None				
H-12	H+11	Squad	76	64	42	7
		ACE	27	19	14	2
		5-Ton Truck	101	64	50	7
		SEE	80	46	37	6
H+12	H+35	Squad	4	17	4	2
		ACE	0	0	0	0
		5-Ton Truck	3	12	4	1
		SEE	0	0	0	0
H+36	H+47	Squad	20	24	15	--
		ACE	8	6	6	--
		5-Ton Truck	26	26	19	--
		SEE	18	14	12	--

Figure D-13

COUNTERMOBILITY REQUIREMENTS
INCREMENT C-2

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

D-18	D-4	None				
D-3	D-1	Squad	6	8	14	--
		ACE	4	8	6	--
		5-Ton Truck	7	7	10	--
		SEE	1	2	1	--
H-Hour	H+11	Squad	54	74	50	--
		ACE	52	72	49	--
		5-Ton Truck	50	65	45	--
		SEE	10	15	9	--
H+12	H+35	Squad	19	88	41	--
		ACE	19	38	38	--
		5-Ton Truck	15	79	31	--
		SEE	4	8	8	--
H+36	H+59	Squad	5	2	1	--
		ACE	0	0	0	--
		5-Ton Truck	3	1	1	--
		SEE	0	0	0	--

European Scenario

D+29	D+42	None				
H-12	H+11	Squad	57	48	31	5
		ACE	20	14	11	2
		5-Ton Truck	76	48	38	5
		SEE	60	35	28	4
H+12	H+35	Squad	3	13	4	1
		ACE	0	0	0	0
		5-Ton Truck	2	9	3	1
		SEE	0	0	0	0
H+36	H+47	Squad	15	18	12	--
		ACE	6	5	4	--
		5-Ton Truck	20	20	14	--
		SEE	13	11	9	--

Figure D-14

D-17

COUNTERMOBILITY REQUIREMENTS
INCREMENT C-3

Time Period		Effort	Brigade Sector			
From	Through	(Hours)	1st	2d	3d	CBAA

SWA Scenario

D-18	D-4	None				
D-3	D-1	Squad	6	8	14	--
		ACE	4	8	6	--
		5-Ton Truck	7	7	10	--
		SEE	1	2	1	--
H-Hour	H+11	Squad	54	74	50	--
		ACE	52	72	49	--
		5-Ton Truck	50	65	45	--
		SEE	10	15	9	--
H+12	H+35	Squad	19	88	41	--
		ACE	19	38	38	--
		5-Ton Truck	15	79	31	--
		SEE	4	8	8	--
H+36	H+59	Squad	5	2	1	--
		ACE	0	0	0	--
		5-Ton Truck	3	1	1	--
		SEE	0	0	0	--

European Scenario

D+29	D+42	None				
H-12	H+11	Squad	57	48	31	5
		ACE	20	14	11	2
		5-Ton Truck	76	48	38	5
		SEE	60	35	28	4
H+12	H+35	Squad	3	13	4	1
		ACE	0	0	0	0
		5-Ton Truck	2	9	3	1
		SEE	0	0	0	0
H+36	H+47	Squad	15	18	12	--
		ACE	6	5	4	--
		5-Ton Truck	20	20	14	--
		SEE	13	11	9	--

Figure D-15

NUMBER OF MINEFIELD MODULES
ALL INCREMENTS

Time Period			Brigade Sector			
From	Through	Type	1st	2d	3d	CBAA

SWA Scenario

From	Through	Type	1st	2d	3d	CBAA
D-18	D-4	None				
D-3	D-1	Air Volcano	2	3	2	--
		Artillery	2	3	2	--
		GEMSS	1	2	1	--
		Ground Volcano	2	3	2	--
H-Hour	H+11	Air Volcano	22	32	16	--
		Artillery	25	42	16	--
		GEMSS	11	16	10	--
		Ground Volcano	21	30	19	--
H+12	H+35	Air Volcano	2	0	9	--
		Artillery	5	0	13	--
		GEMSS	4	8	8	--
		Ground Volcano	7	14	15	--
H+36	H+59	Air Volcano	3	0	0	--
		Artillery	9	0	0	--
		GEMSS	0	0	0	--
		Ground Volcano	0	0	0	--

European Scenario

From	Through	Type	1st	2d	3d	CBAA
D+29	D+42	None				
H-12	H+11	Air Volcano	5	4	3	1
		Artillery	8	4	3	1
		GEMSS	5	3	2	0
		Ground Volcano	8	6	4	1
H+12	H+35	None				
H+36	H+47	Air Volcano	5	8	4	1
		Artillery	8	16	6	3
		GEMSS	1	1	1	--
		Ground Volcano	2	2	2	--

Figure D-16

NUMBER OF POINT TARGETS
ALL INCREMENTS

Time Period			Brigade Sector			
From	Through	Type	1st	2d	3d	CBAA

SWA Scenario

From	Through	Type	1st	2d	3d	CBAA
D-18	D-4	None				
D-3	D-1	Road crater	4	17	7	--
		Bridge demolitions	0	1	6	--
		Abatis	--	--	--	--
H-Hour	H+11	Road crater	111	164	101	--
		Bridge demolitions	0	0	0	--
		Abatis	--	--	--	--
H+12	H+35	Road crater	41	84	85	--
		Bridge demolitions	1	2	3	--
		Abatis	--	--	--	--
H+36	H+59	Road crater	--	--	--	--
		Bridge demolitions	4	2	1	--
		Abatis	--	--	--	--

European Scenario

From	Through	Type	1st	2d	3d	CBAA
D+29	D+42	None				
H-12	H+11	Road crater	194	117	94	14
		Bridge demolitions	5	22	7	1
		Abatis	15	11	8	1
H+12	H+35	Road crater	0	0	0	0
		Bridge demolitions	5	22	7	1
		Abatis	0	0	0	0
H+36	H+47	Road crater	44	34	29	--
		Bridge demolitions	3	11	3	--
		Abatis	7	6	5	--

Figure D-17

NUMBER OF OTHER LINEAR TARGETS
ALL INCREMENTS
(Meters)

Time Period			Brigade Sector			
From	Through	Type	1st	2d	3d	CBAA

SWA Scenario

From	Through	Type	1st	2d	3d	CBAA
D-18	D-4	None				
D-3	D-1	Tank ditch	510	899	657	--
		Wire	316	0	505	--
H-Hour	H+11	Tank ditch	6,124	8,572	5,762	--
		Wire	516	0	823	--
H+12	H+35	Tank ditch	2,215	4,535	4,504	--
		Wire	0	0	0	--
H+36	H+59	None				

European Scenario

From	Through	Type	1st	2d	3d	CBAA
D+29	D+42	None				
H-12	H+11	Tank ditch	2,394	1,698	1,270	178
		Wire	1,197	849	635	89
H+12	H+35	None				
H+36	H+47	Tank ditch	672	576	490	0
		Wire	336	288	245	0

Figure D-18

requirements, engineer assets were tasked to emplace only 39 percent, while aviation and artillery assets were responsible for 25 and 36 percent, respectively. It was assumed that 30 percent of the field artillery tubes were available for mine missions. This follows the Field Artillery School's rule of thumb that associates the frequency of an artillery firing mission with its corresponding percentage in the basic load. The percentage of ADAM/RAAM rounds within the division's basic load (240 rounds) is 23 percent, and that percentage can be expected to rise as much as an additional 7 percent in the defense.

PERCENTAGE OF MINEFIELDS

| | Scenario | | Division |
	SWA	Europe	Average
Aviation	24	26	25
Artillery	30	42	36
Engineer	46	32	39

Figure D-19

(2) In scenarios which do not allow the use of scatterable mines, the engineers would bear the entire minefield burden. The advent of scatterable mine systems has spread the workload among three branches of the theater army, freeing engineer capability for other countermobility tasks. Figure D-20 indicates the savings in squad- and equipment-hours gained by using aviation and artillery-delivered minefields to supplement engineer-emplaced minefields in the overall barrier plan.

(3) If the 9ID(MTZ) relied solely on engineer minefields, then between 132 to 314 additional squad-hours of effort would be required to complete each scenario barrier plan. Engineers could not compensate totally

D-22

for aviation and artillery-delivered minefields, since it would be impractical to employ the Ground Volcano in counterattack situations which require the placement of a minefield between the Soviet's first and second echelon forces.

SUBSTITUTION OF GROUND VOLCANO FOR AVIATION
AND ARTILLERY MINEFIELDS

Module Type	Number of Modules	Ground Volcano Equivalent	Squad-Hour Savings
SWA Scenario			
Aviation	91	55	106
Artillery	108	108	208
TOTAL			314
European Scenario			
Aviation	31	19	37
Artillery	49	49	95
TOTAL			132

Figure D-20

b. TEXS. ESC investigated the use of TEXS by the 9ID(MTZ) by evaluating how the division used the TEXS to execute tank ditches in both scenarios. Figure D-21 compares the effort necessary to construct 1000 meters of tank ditch using TEXS with that required if a pair of M9 ACEs are used instead.

TANK DITCH*
(1000 m)

Method	Squad-Hours	Explosives (Tons)	Equipment-Hours			Elapsed Time (Hours)
			ACE	SEE	5-Ton Truck	
TEXS	11.18	13.3	--	10	10	12.18
ACES (2 each)	0.73	--	28.14	--	--	14.8

*Does not include equipment-hours required to mine the tank ditch.

Figure D-21

(1) The comparison indicates that the TEXS does work more efficiently than the ACE; the ACE equipment-hours saved by using the TEXS could be diverted to other mobility or survivability missions. The TEXS method also makes effective use of the SEE and is very appropriate in situations where the engineers have significant lead time prior to hostilities. However, the TEXS is very labor and Class V intensive--its major drawbacks. Eleven squad-hours are required to execute a tank ditch with the TEXS, compared with only 0.73 squad-hours expended when the ACE method of tank ditching is used. TEXS also requires 13.3 tons of explosive that non-explosive tank ditches do not require. Both systems require the same number of mines.

(2) The TEXS would be the best way to dig a tank ditch in situations where manhours, Class V supply, or the use of 5-ton trucks was not critically constrained, or in instances where the demand for the ACE exceeds supply. However, under the scenarios considered by this analysis, all four resources were limited. Therefore, squad-hours and Class V supply were used as the deciding factors for choosing the ACE over the TEXS.

c. GEMSS excursion. The effect the absence of the Ground Volcano and the Air Volcano mine systems would have on the 9ID(MTZ)'s ability to install its barrier plan was analyzed. In this excursion, it was assumed that the division would be equipped with GEMSS as a surrogate for the Ground Volcano, but would have no substitute for the Air Volcano system. ESC then took the total requirement for Ground Volcano and Air Volcano modules, converted it to an equivalent number of GEMSS modules, and calculated the effort in squad-hours required to emplace the minefields. GEMSS was not designed to execute all the required Air Volcano minefields (especially those in support of counterattacks); however, those counterattack minefields were not included in the

D-24

total equivalent GEMSS effort. Figure D-22 shows the effort in terms of tonnage and squad-hours. Although a savings of 28 to 32 percent in Class V tonnage is realized, using GEMSS increases the squad-hour requirement by as much as 142 to 148 percent, depending on the scenario. This analysis provides further evidence in support of the opinion that the new scatterable mine systems such as the Ground Volcano and Air Volcano will be more efficient than current state-of-the-art systems like the GEMSS.

GEMSS EXCURSION

Delivery System	Number of Minefield Modules	Tons	Squad-Hours to Emplace
SWA Scenario			
Ground Volcano	112	424	216
Air Volcano	78	177	*
Total	190	601	216
GEMSS Equivalent	215	434	522
Savings	NA	167	-306
		(28%)	(-142%)
European Scenario			
Ground Volcano	25	95	48
Air Volcano	23	52	*
Total	48	147	48
GEMSS**	49	100	119
Savings	NA	47	-71
		(32%)	(-148%)

*This effort is expended by non-engineers, so it was not quantified.
**GEMSS modules were used instead of Ground Volcano and Air Volcano in both scenarios.

Figure D-22

d. Road craters. The motorized division is well equipped to install linear targets quickly and with minimal engineer effort--much better equipped than they are to emplace point targets, especially road craters. Although the M180 cratering demolition kit requires only 0.56 squad-hours of effort to create a road crater, it is relatively ineffective on asphalt and concrete surfaces. When faced with those surfaces, engineers usually rely on 40-lb shape and cratering charges to blast a deliberate road crater. This labor-intensive process involves an engineer squad for 2.35 hours.

(1) In an attempt to reduce the engineer effort for road craters on asphalt and concrete surfaces, the squad-hour requirement was evaluated to see how it would change if shape and cratering charges were replaced with the SEE. On asphalt surfaces, the backhoe attachment of the SEE is used to rip and clear the pavement from the roadway in two strips (each strip is 8 x 0.33 m). Once the asphalt has been removed, the M180 demolition kit is used to crater the road. Concrete surfaces, which are encountered only in the European scenario, are a greater challenge. The squad first had to break the concrete surface using the pavement breaker attachment of the SEE. After the reinforcing mesh was cut and any existing reinforcing bars bent out of the way, the SEE's backhoe removes enough broken concrete to accommodate five M180 cratering demolitions kits.

(2) Figure D-23 shows the estimated effort in squad-hours and dominant equipment-hours for each typical surface encountered in the SWA and European scenario areas.

(3) Using the SEE to crater a road can save 0.53 squad-hours per crater under the SWA scenario; the savings under the European scenario are 1.24 squad-hours per crater.

ROAD CRATERING ALTERNATIVES

Method	Surface	Percentage of Occurrence		Effort (Hours)			Elapsed Time
		SWA	Europe	Squad	5-Ton Truck	SEE	
M180[a]	Unpaved[b]	70	30	0.57	0.5	--	0.57
	Asphalt	30	45	0.57	0.5	1.0	1.57
	Concrete	--	25	0.59	2.6	2.0	2.59
Conventional[c]	Paved[d]	30	70	2.35	2.4	--	2.63

[a]A tripod-mounted cratering kit consisting of a standard 15-lb shape charge and a rocket-propelled 40-lb cratering charge.
[b]Compacted earth or gravel surfaces.
[c]40-lb shape and cratering charges.
[d]Both asphalt and concrete surfaces required approximately the same effort.

Figure D-23

e. Haul capability. Although the tonnages of countermobility materials used were not presented, the sheer number of linear and point obstacles installed raises a question concerning the engineer battalion's haul capability. After D-day in both scenarios, the engineer battalion's 32 five-ton cargo trucks are all occupied as prime movers for a LAB or MICLIC, or are hauling the volcano system and tank and pump dispensers. That leaves no excess cargo trucks within the engineer battalion. The engineer squad vehicle, a HMMWV, has limited space for a six-man crew, their personal gear, and squad equipment. Despite this obvious shortfall in haul capability, the engineer battalion is required to transport its mines and other barrier material from the BSA to the various work sites throughout the CFA and MBA. The 9ID(MTZ)'s barrier plan is ambitious and logistically demanding yet study findings signal a failure of the engineers to complete the MBA obstacle plans,

not because of a manpower shortfall, but rather due to a shortage of organic

engineer haul capability. Annex G presents a more detailed look at this

particular issue.

ANNEX E

SURVIVABILITY REQUIREMENTS

ANNEX E

SURVIVABILITY REQUIREMENTS

1. <u>Purpose</u>. This annex discusses the assumptions and limitations of the methodology used to evaluate survivability tasks for the 9ID(MTZ) under the SWA and European scenarios, and lists the division's survivability requirements for each scenario.

2. <u>Scope</u>. This analysis:

a. Identified those tasks which were most likely to have a significant effect on the division's ability to survive on the battlefield.

E-1

b. Constructed an algorithm for calculating the engineer effort associated with each task.

c. Determined the survivability requirements for each case and battle phase of the scenarios considered by this study.

3. Engineer Survivability Tasks. Survivability involves the development of protective positions for critical weapon and support systems in the division area. Position requirements for all FA and ADA units are included in this engineer mission. Protective construction for the division CP and DISCOM activities located to the rear of the brigade rear boundaries are considered general engineering tasks for which requirements are calculated separately and listed in Annex F.

a. Figure E-1 lists the major survivability tasks grouped into four increments. Each battle phase is listed separately. The composition of each increment was determined by the SAG.

b. Figure E-2 shows the ranking by battle phase of each survivability task. The left column indicates which system is to be protected. The right four columns indicate the priority of tasks during lodgement, offense, and defense. The increments are ranked from the highest priority (Increment S-1) to the lowest (Increment S-4). Rankings were determined by the SAG.

4. Methodology. Figure E-3 outlines the method used to generate survivability requirements. This diagram was used to estimate requirements for the SWA and European scenarios (see Volume II). However, different planning factors were used for each scenario-dependent period of battle. Of the five key steps (middle row of Figure E-3) included in this methodology, only the second (number of protectable items) is a constant across all scenarios. The third factor (cover availability) is a constant for any one scenario. The

SURVIVABILITY INCREMENTS

Phase	Increment	Description
Lodgement	S-1	Protect TOWs, PGATMs, communication nodes, CASC, and CPs.
	S-2	Protect assault guns, cannon artillery, critical I/EW equipment/facilities, TOC equipment, POL forward storage points, and ATPs.
	S-3	Protect MK-19, radar systems, MLRS, and FARRPs.
	S-4	Protect Vulcan, Chaparral, Hawk, and mortars.
Offense	S-1	Protect assault guns, MLRS, and CPs.
	S-2	Protect TOWs, PGATMs, TOC equipment, POL forward storage points, cannon artillery, communication nodes, critical I/EW equipment/facilities, CASC, FAARPs, and ATPs.
	S-3	Protect MK-19, Hawk, and radar systems.
	S-4	Protect Vulcan, Chaparral, and mortars.
Defense	S-1	Protect TOWs, PGATMs, communication nodes, CASC, critical I/EW equipment/facilities, and CPs.
	S-2	Protect assault guns, MK-19, Vulcan, TOC equipment, POL forward storage points, and ATPs.
	S-3	Protect Hawk, radar systems, cannon artillery, MLRS, and FARRPs.
	S-4	Protect Chaparral and mortars.

Figure E-1

SURVIVABILITY TASKS AND INCREMENT GROUPINGS

	Increment Group*			
Task (Weapon/Equipment to Be Dug In)	S-1	S-2	S-3	S-4
1. Direct-Fire Weapons				
Assault guns	O	L,D		
TOW	L,D	O		
MK-19		D	L, O	
PGATM	L,D	O		
Dragon	L,D	O		
2. Air Defense Weapons--Division				
Vulcan		D		L,O
Chaparral				All
3. Air Defense Weapon System--EAD			D,O	L
4. Radar Systems			All	
5. Indirect-Fire Weapons				
Field Artillery--Division (155-mm howitzer)		L,O	D	
Field Artillery--EAD (155-mm towed howitzer, 8-in. howitzer)		L,O	D	
Mortar				All
MLRS--Division	O		L,D	
MLRS--EAD	O		L,D	
6. Command Centers				
Communication Nodes--Division	L,D	O		
CASC--EAD	L,D	O		
Critical I/EW equipment/facilities	D	L,O		
TOC equipment--Brigade		All		
Command Posts--Brigade	All			
7. Forward Logistics Protection				
FARRP		O	L,D	
POL forward stockage points--Brigade		All		
ATPs--Brigade		All		

*L = Lodgement; O = Offense; D = Defense

Figure E-2

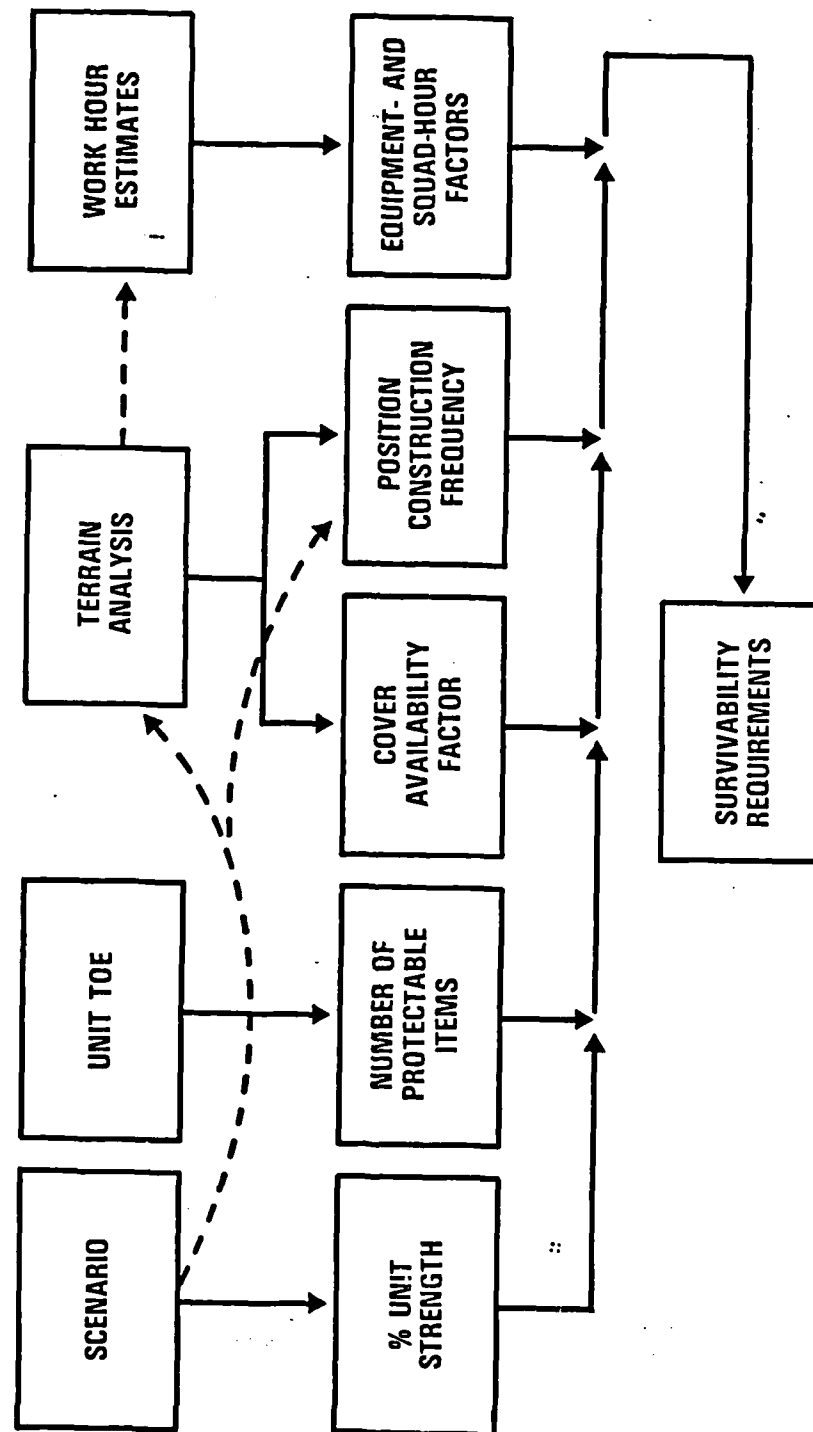# SURVIVABILITY REQUIREMENTS METHODOLOGY

Figure E-3

percentage of unit strength (first factor), position construction frequency (fourth factor), and equipment- and squad-hour factor (last factor) are all relatively variable from one period to another. Unit TOEs provided the initial number of items to be protected. As each scenario proceeded, the number of items to be protected was reduced based on time- and scenario-dependent unit strength factors extracted from the scenario data. The terrain analysis conducted by ESC analysts determined the percentage of natural cover available for each division AO. The number of survivability positions and the frequency of moves to supplementary or alternate positions was determined from interviews with 9ID(MTZ) personnel, unit concepts of operation, and other sources. Standard engineer work-hour estimates were finally applied to this equation to obtain the overall survivability requirements. The details of this methodology, the steps of each analysis, and the assumptions are discussed in the following paragraph.

    5. <u>Discussion</u>. Figure E-4 shows the algorithm derived from the methodology diagram shown in Figure E-3.

SURVIVABILITY REQUIREMENTS ALGORITHM

Engineer Requirements (Equipment-hours/Manhours) =

Items to Be Protected	X	% Unit Strength	X	% Without Natural Cover	X	Number of Moves	X	Hours Per Item

---

Figure E-4

    a. ESC and the SAG determined which items are to be protected. This information was furnished during a visit by the ESC study team to the 9ID(MTZ) in November 1984 and is based on the TOE for the 9ID(MTZ) and EAD for the 1986

timeframe, as well as the concepts of operation at each level of command within the 9ID(MTZ). These data are relatively constant across both scenarios, except for Case II (the EAD). This difference is based on the EAD support needs for the 9ID(MTZ) for each scenario.

b. The scenarios drive the percentage of unit strength at any integral period of battle. These data are taken from the scenario wargaming results and are factored into the equation to give the total weapon and equipment systems requiring protection for a given period of the battle. Volume II of this study gives the attrition rates used to determine the percentage of unit strength at each period of battle for each scenario.

c. Not all weapon systems and equipment require the same degree of protection on the battlefield. The opportunity that various units will have to use available natural cover is a function of the terrain analysis for a specific scenario. Figure E-5 shows a set of algorithms and factors used by ESC in estimating the relative nonavailability of natural cover for specific weapon and equipment systems. These factors were developed by ESC and based on natural cover availability overlays for direct-fire weapon systems. The percentage of positions without natural cover (values C1 through C7) becomes a part of the algorithm.

(1) Note that radar systems, which must be in the open to operate effectively, cannot use natural cover and will require all of their positions to be dug in (value C1).

(2) ADA fire and control systems are assumed to have only half the opportunity of direct-fire weapon systems in finding natural cover. This is because they require clear fields of fire in all directions.

POSITIONS WITHOUT NATURAL COVER
(Percentage)

Item	Algorithm Used for Specific Terrain Area
	(a) (b) (c) (d)
Radar Systems[e]	$100 - [A \times 0.0 = B^1] = C^1$
ADA Firing Units[f]	$100 - [A \times 0.5 = B^2] = C^2$
ADA Control	$100 - [A \times 0.5 = B^3] = C^3$
Direct-Fire Vehicles[g]	$100 - [A \times 1.0 = B^4] = C^4$
FA Pieces & Ammunition Vehicles	$100 - [A \times 1.5 = B^5] = C^5$
Mortars	$100 - [A \times 2.0 = B^6] = C^6$
Command Vehicles	$100 - [A \times 2.0 = B^7] = C^7$

[a] A = Natural cover available for direct-fire weapon vehicles.

[b] Factors relative to direct-fire weapon vehicles.

[c] B = Adjusted natural cover availability.

[d] C = Percentage of positions without natural cover (percentage of positions to be dug in). C^1 will always be 100 percent for radar systems.

[e] FAAR; Hawk radar, LEWR, field artillery target acquisition radar vans.

[f] Hawk, Chaparral, Vulcan.

[g] LAV-25; LFV; HMMWV (includes personnel carriers, equipment vehicles, etc.)

Figure E-5

(3) FA weapon and support systems are assumed to have 1.5 times the opportunity for finding natural protection as direct-fire weapons. This is because of their greater distance from the FEBA and their greater ability to locate behind masking terrain.

(4) Mortar systems and CPs have twice the opportunity for finding natural cover than direct-fire weapons. Mortars occupy a smaller area and are much more easily displaced. CPs have much more freedom to choose locations.

(5) Cover availability for direct-fire weapon systems were determined to be 12 percent for the SWA scenario and 4 percent for the European scenario.

d. Terrain analysis driven by the scenario provides the opportunity to determine the frequency of moves required during each period of battle. It also indicates the locations of the weapon and equipment systems requiring protection. Volume II gives the relative movement of units and boundaries during each period of each scenario. These derived-data are also fed into the formula. They include supplementary and alternate positions as required by the scenario.

e. ESC determined the engineer equipment- and squad-hours required for each position based on the results of ESC's field surveys, questionnaires and interviews, previous research, and standard engineer references, such as E-FOSS.[1] These estimates vary depending on the terrain analysis (soil types, soil conditions, slope, etc). Figure E-6 shows the engineer requirements for protective construction in the brigade areas.

_____

[1]DA, USAES, DCD, Engineer Family of Systems Study (E-FOSS), (hereafter referred to as E-FOSS).

ENGINEER PLANNING FACTORS FOR PROTECTIVE CONSTRUCTION

Tasks	Man-Hours	ACE/Dozer	Loader	Notes
		Equipment-Hours		
Berm for radar		0.8	1.8	a
Berm for Hawk Battery launcher (6/battery) (each)		2.5	1.2	b
Berm for Hawk generator		0.8		b
Berm for Hawk Info Center		0.8	1.8	b
Slot for ADA CP		0.6	0.6	b
Berm for 155-mm howitzer		0.8		a
Slot for FDC, ammo carrier, prime mover (each)		1.3		a
Berm for 105-mm howitzer		0.8		c
Berm for 8-in. howitzer		0.8		a
Berm for communications node (20 vehicles/node)	2.3	19.2	33.6	c
Berm for CASC node	2.3	27.5	50.4	c

[a]E-FOSS estimate
[b]ESC-modified E-FOSS estimate
[c]ESC estimate

Figure E-6

f. Figure E-7 is an example of the survivability algorithm shown in

Figure E-4, using brigade area "A" during period 2 of the European scenario.

FACTORS IN A SAMPLE SURVIVABILITY CALCULATION

Howitzers in FA Bn		% Unit Strength		% Without Natural Cover		Number of Moves		Dozer-hours per piece		Dozer-hour Requirements
18	X	0.92	X	0.94	X	2	X	0.8	=	24.9 hrs

Note: The tables in Figures E-8, E-9 and E-10 are derived from similar calculations for all survivability requirements.

Figure E-7

6. Results.

a. Figures E-8 to E-10 summarize the engineer requirements for survivability for each increment and scenario. These requirements are further divided into unit areas and periods of battle. Both Case I (division-only) and Case II (EAD-only) are represented; however, Case II results are combined for all unit areas.

SURVIVABILITY REQUIREMENTS--S-1

Duration		Effort	Division Requirements			EAD*
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	Requirements
		(SWA Scenario)				
D-18	D-4	Squad				0.2
		ACE/D7				13.8
		Loader				25.2
D-3	D-1	Squad	0.3	0.3	0.3	0.2
		ACE/D7	19.2	19.2	19.2	13.7
		Loader	33.6	33.6	33.6	25.2
H-Hour	H+11	(none)				
H+12	H+35	Squad				0.3
		ACE/D7				27.5
		Loader				50.4
		(European Scenario)				
D+29	D+42	(none)				
H-12	H+11	Squad	0.3	0.3	0.3	
		ACE/D7	17.5	17.5	17.5	
		Loader	30.6	30.6	30.6	
H+12	H+35	Squad	0.3	0.3	0.3	
		ACE/D7	17.3	17.3	17.3	
		Loader	30.3	30.3	30.3	
H+36	H+47	(none)				

*All unit areas combined.

Figure E-8

SURVIVABILITY REQUIREMENTS--S-2

Duration		Effort	Division Requirements			EAD*
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	Requirements

(SWA Scenario)

D-18	D-4	(none)				
D-3	D-1	(none)				
H-Hour	H+11	ACE/D7	42.7	37.4	48.0	85.4

(European Scenario -- no effort)

*All unit areas combine.

Figure E-9

SURVIVABILITY REQUIREMENTS--S-3

Duration		Effort	Division Requirements				EAD*
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements

(SWA Scenario)

D-18	D-4	ACE/D7				19.2	
		Loader				43.2	
D-3	D-1	ACE/D7	60.6	59.0	60.4	3.2	173.6
		Loader	16.2	12.6	16.2	7.2	38.4
H-Hour	H+11	ACE/D7	7.2	5.6	7.2		
		Loader	16.2	12.6	16.2		
H+12	H+35	ACE/D7	74.4	64.6	94.4	3.2	198.6
		Loader	32.4	25.2	32.4	7.2	38.4
H+36	H+59	ACE/D7	51.8	54.0	57.2		81.8
		Loader	32.4	25.2	32.4		

(European Scenario)

D+29	D+42	(none)					
H-12	H+11	ACE/D7	130.5	118.7	130.5		521.3
		Loader	17.6	10.6	17.6		39.6
H+12	H+35	ACE/D7	124.0	112.7	124.0		144.3
		Loader	17.1	10.3	17.1		
H+36	H+48	ACE/D7	60.0	54.5	60.0		420.3
		Loader	8.4	5.0	8.4		37.6

*All unit areas combined.

Figure E-10

E-12

b. There are no survivability requirements for increment S-4 in the SWA scenario or for increments S-2 and S-4 in the European scenario. Figure E-11 shows why these tasks are not required. There is no S-2 increment in Europe because this scenario has no offensive period of battle. (The data from Figures E-1 and E-2 are linked to the scenarios and form the basis for the survivability requirements.) Note that the interviews conducted with key members of the 9ID(MTZ) constitute the main reason for not undertaking some of the tasks listed in Figures E-1 and E-2. Study Excursion E analyzes the effect of undertaking the task of digging in direct-fire weapons (see Annex I).

UNREQUIRED SURVIVABILITY INCREMENTS

Systems Not Protected	Reason			Increment		
				SWA	Europe	
	O&O Concept	Interviews*	Scenario	S-4	S-2	S-4
Direct-Fire Weapons	X	X			X	
Division ADA Weapons	X	X		X	X	X
EAD ADA Weapons			X	X		X
Mortars			X		X	X

*13-16 November 1984.

Figure E-11

c. The survivability workload (tasks to be accomplished) is shown in Figures E-12 (SWA scenario) and E-13 (European scenario). These figures include the factors found in the Survivability Requirements Algorithm (Figure E-4). Note that the survivability effort for division CPs, DISCOM, and other units located in the DRA are not included in this annex, but are found in the General Engineering Annex (Annex F). To be more consistent in the methodology, only the Hawk ADA and radar units located in the DRA were included in these survivability requirements calculations.

SURVIVABILITY WORKLOAD
(SWA Scenario)

Duration		Effort by Task	Brigade Area			
From	Through		1st	2d	3d	DRA

Increment S-1:

From	Through	Effort by Task	1st	2d	3d	DRA
D-18	D-4	Berms for 1/2 CASC vehicles		10		
D-3	D-1	Berms for comme node vehicles	20	20	20	
		Berms for 1/2 CASC vehicles	10			
H+12	H+35	Berms for CASC vehicles		13		

Increment S-2:

From	Through	Effort by Task	1st	2d	3d	DRA
H-Hour	H+11	Indirect-Fire Weapons--Division				
		Berms for 155-mm howitzers	13	13	13	
		Berms for 105-mm howitzers	4	4	4	
		Slots for ammo carriers	13	13	13	
		Slots for prime movers	13	13	13	
		Slots for FDC vehicles	3	3	3	
		Indirect-fire weapons--EAD				
		Berms for 155-mm howitzers	9	9	9	
		Slots for ammo carriers	9	9	9	
		Slots for prime movers	9	9	9	
		Slots for FDC vehicles	2	2	2	

Increment S-3:

From	Through	Effort by Task	1st	2d	3d	DRA
D-3	D-1	Indirect-Fire Weapons--Division				
		Berms for 155-mm howitzers	18	18	18	
		Berms for 105-mm howitzers	6		6	
		Slots for ammo carriers	18	18	18	
		Slots for prime movers	24	18	24	
		Slots for FDC vehicles	4	3	4	
		Indirect-fire weapons--EAD				
		Berms for 155-mm howitzers	12	12	12	
		Slots for ammo carriers	12	12	12	
		Slots for prime movers	12	12	12	
		Slots for FDC vehicles	2	2	2	
		Radar systems--Division				
		Berms for radar systems	9	7	9	24
		Air Defense Artillery--EAD				
		Berms for Hawk launchers	6	6	6	6
		Berms for Hawk generators	1	1	1	1
		Berms for Info Coord Center	1	1	1	1
		Slots for battery CPs	1	1	1	1
		Slots for platoon CPs	1	1	1	1

Figure E-12 (Continued On Next Page)

SURVIVABILITY WORKLOAD--Continued
(SWA Scenario)

Duration		Effort by Task	Brigade Area			
From	Through		1st	2d	3d	DRA

Increment S-3 (continued):

Duration		Effort by Task	Brigade Area			
From	Through		1st	2d	3d	DRA
H-Hour	H+11	Radar systems--Division				
		Berms for radar systems	8	6	8	3
H+12	H+35	Indirect-fire weapons--Division				
		Berms for 155-mm howitzers	29	29	29	
		Berms for 105-mm howitzers	10		10	
		Slots for ammo carriers	29	29	29	
		Slots for prime movers	38	35	38	
		Slots for FDC vehicles	6	5	6	
		Indirect-fire weapons--EAD				
		Berms for 155-mm howitzers	20	20	20	
		Slots for ammo carriers	20	20	20	
		Slots for prime movers	20	20	20	
		Slots for FDC vehicles	3	3	3	
		Radar systems--Division				
		Berms for radar systems	17	13	17	7
		Air Defense Artillery--EAD				
		Berms for Hawk launchers	6	6	6	6
		Berms for Hawk generators	1	1	1	1
		Berms for Info Coord Center	1	1	1	1
		Slots for battery CPs	1	1	1	1
		Slots for platoon CPs	1	1	1	1
H+36	H+59	Indirect-fire weapons--Division				
		Berms for 155-mm howitzers	26	26	26	
		Berms for 105-mm howitzers	9		9	
		Slots for ammo carriers	26	26	26	
		Slots for prime movers	35	26	35	
		Slots for FDC vehicles	7	5	7	
		Indirect-fire weapons--EAD				
		Berms for 155-mm howitzers	18	18	18	
		Slots for ammo carriers	18	18	18	
		Slots for prime movers	18	18	18	
		Slots for FDC vehicles	3	3	3	
		Radar systems--Division				
		Berms for radar systems	16	13	16	7

Figure E-12

E-15

SURVIVABILITY WORKLOAD
(European Scenario)

Duration			Brigade Area			
From	Through	Effort by Task	1st	2d	3d	DRA

Increment S-1:

H-12	H+11	Berms for commo node vehicles	20	20	20	
H+12	H+35	Berms for commo node vehicles	20	20	20	

Increment S-3:

H-12	H+11	Indirect-fire weapons—Division				
		Berms for 155-mm howitzers	33	33	33	
		Berms for 105-mm howitzers	11	11		
		Slots for ammo carriers	44	33	44	
		Slots for prime movers	44	33	44	
		Slots for FDC vehicles	7	5	7	
		Indirect-fire weapons—EAD				
		Berms for 8-in. howitzers	22	22	22	
		Slots for FDC vehicles	4	4	4	
		Slots for ammo carriers	22	22	22	
		Air Defense Artillery—EAD				
		Berms for Hawk Launchers	6	6	6	6
		Berms for Hawk generators	1	1	1	1
		Berms for Info Coord Center	1	1	1	1
		Slots for battery CPs	1	1	1	1
		Slots for platoon CPs	1	1	1	1
		Radar systems—Division & EAD				
		Berms for radar systems	18	14	18	8
H+12	H+35	Indirect-fire weapons—Division				
		Berms for 155-mm howitzers	31	31	31	
		Berms for 105-mm howitzers	10	10		
		Slots for ammo carriers	42	31	42	
		Slots for prime movers	42	31	42	
		Slots for FDC vehicles	7	5	7	
		Indirect-fire weapons—EAD				
		Berms for 8-in. howitzers	21	21	21	
		Slots for FDC vehicles	3	3	3	
		Slots for ammo carriers	21	21	21	
		Radar systems—Division & EAD				
		Berms for radar systems	17	13	17	7
H+36	H+47	Indirect-fire weapons—Division				
		Berms for 155-mm howitzers	15	15	15	
		Berms for 105-mm howitzers	5		5	
		Slots for ammo carriers	20	15	20	
		Slots for prime movers	20	15	20	
		Slots for FDC vehicles	3	2	3	
H+36 (Con't)	H+47	Indirect-fire weapons—EAD				
		Berms for 8-in. howitzers	10	10	10	
		Slots for FDC vehicles	2	2	2	
		Slots for ammo carriers	10	10	10	
		Air Defense Artillery—EAD				
		Berms for Hawk launchers	5	5	5	5
		Berms for Hawk generators	1	1	1	1
		Berms for Info Coord Center	1	1	1	1
		Slots for battery CPs	1	1	1	1
		Slots for platoon CPs	1	1	1	1
		Radar systems—Division & EAD				
		Berms for radar systems	8	6	8	4

Figure E-13

7. Observations.

a. The analysis of the major "digging-in" requirements was based on the capacity of the 2.5-CY loader because it was assumed that a corps and its engineer equipment would support the 9ID(MTZ). In situations where the division is not directly supported by a corps, or where the corps' engineer equipment is occupied with other tasks, the 9ID(MTZ)'s SEE 0.75-CY bucket would substitute for the 2.5-CY loader. Since the SEE cannot move as much earth as quickly as the loader, in a division-only situation like Case I, the requirement totals listed under "loader" in Figures E-8 through E-10 would triple.

b. The 9ID(MTZ) does achieve maximum combat effectiveness, including survivability, primarily through high-force mobility. It attempts to avoid rather than withstand enemy fires. Its defensive tactics are local and temporary, focusing on the destruction of the enemy rather than on the retention of terrain. With this in mind, there are relatively few survivability requirements for maneuver elements of the 9ID(MTZ). Mobility is survivability.

ANNEX F

GENERAL ENGINEERING REQUIREMENTS

ANNEX F

GENERAL ENGINEERING REQUIREMENTS

1. Purpose. This annex presents the methodology used to estimate the workload requirements for general engineering tasks under the SWA and European scenarios. These requirements are based on the task priority list developed by the SAG, using the task increment system developed by ESC for the

engineering capability assessments conducted for the III, V, and II US Corps in Europe.[1]

2. <u>Scope</u>. The analysis described in this annex:

a. Defines 30 general engineering tasks for the 9ID(MTZ) under the scenarios considered by this study.

b. Assigns discrete planning factors to each engineer task and functional area.

c. Estimates the requirements for and workload generated by each general engineering task, by increment and scenario.

3. <u>Methodology</u>.

a. Step 1: define and rank general engineering tasks. General engineering tasks occur behind the brigade rear boundaries and provide tactical or logistical support to maneuver elements. For the purposes of this study, engineer tasks located in the BSAs also were considered general engineering tasks. These general engineering tasks include support to the LOC system and important combat service support, and support provided to communication and CP facilities within the DRA and BSAs.

(1) Figure F-1 lists the 30 general engineering tasks considered likely to generate requirements for the 9ID(MTZ) engineers under the scenarios considered by this study. Figure F-1 also indicates the relative priority of each task during the lodgement, offense, and defense phases. These priorities were assigned by the SAG using ESC's task ranking system (see Annex A).

(2) ESC asked the SAG to group all 30 possible general engineering tasks, by battle phase, in terms of four priority increments: Increment

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[1]DA, USACE, ESC, <u>Analysis of III Corps Combat Engineer Wartime Requirements; Analysis of V Corps Combat Engineer Wartime Requirements; and Analysis of VII Corps Combat Engineer Wartime Requirements.</u>

GENERAL ENGINEERING TASKS AND INCREMENTS
DURING THE SCENARIO BATTLE PHASES

Task	Description	Battle Phase*		
		L	D	O
1	MSR Damage Repair	1	1	1
2	MSR Bridge Damage Repair	1	1	1
3	MSR Maintenance Repair	3	2	3
4	MSR Bridge Maintenance Repair	2	2	3
5	MSR Improvement (dimensions/surface)	2	4	3
6	Expedient Construction of MSR Bridges	2	4	3
7	Division Airfield Preparation	2	2	3
8	Division Airfield Damage Repair (MAOS)	1	2	2
9	Division Airfield Maintenance Repair (AOS)	2	4	4
10	Division Pioneer Access Road Construction	3	2	1
11	EAD Pioneer Access Road Construction	3	2	1
12	Division Pioneer Access Road Maintenance Repair	3	3	2
13	EAD Pioneer Access Road Maintenance Repair	3	3	2
14	Division CP and DISCOM Protective Construction	2	1	1
15	Division CP and DISCOM Damage Repair	3	2	3
16	Division Signal Support	2	1	3
17	EAD Signal Support--CASC	2	1	3
18	EAD Ammunition Storage Site Preparation	1	3	2
19	EAD Ammunition Storage Site Damage Repair	3	4	4
20	Division General Supply Site Preparation	4	4	4
21	Division General Supply Site Damage Repair	3	4	2
22	EAD General Supply Site Preparation	4	4	4
23	EAD General Supply Site Damage Repair	3	4	2
24	POL Storage Site Preparation	1	3	2
25	POL Storage Site Damage Repair	3	3	2
26	Maintenance Unit Site Preparation	3	3	4
27	Maintenance Unit Site Damage Repair	3	3	4
28	EAD Support to Medical Activities	3	1	2
29	Enemy Prisoner of War (EPW) Cage Site Preparation	4	4	3
30	Terminate/Restore Utilities	3	4	4

*L = Lodgement; D = Defense; O = Offense.

Figure F-1

G-1 containing those tasks which the SAG believed should be done first during the battle phase, and Increment G-4 those which should be left to the last. Figures F-2, F-3, and F-4 present the results of the SAG's increment ranking exercise for the lodgement, offense, and defense phases of battle. Figure F-5 summarizes the information listed in Figures F-1 through F-4.

b. Step 2: establish a measurement base. The tactical situation dictated by the scenarios frequently changes the overall requirements for each general engineering task. ESC did not, therefore, develop a system for assigning broad, general workload factors to each general engineering task. Instead, the engineer effort needed to complete each task was quantitatively estimated for three engineer work categories. The analysis team divided all of the 9ID(MTZ)'s 30 general engineering tasks into three broad work categories: damage repair, expedient construction, and maintenance repair. Each of the 9ID(MTZ)'s 30 general engineering tasks were then redistributed among 16 functional areas. Figure F-6 shows which tasks were placed in each functional area and work category.

c. Step 3: adjust measurement base. After the measurement data base was developed, it was adjusted using the estimated workload factors shown in Figures F-7 and F-8. These adjustment factors considered two sets of variables which most significantly influence the requirements for general engineering. The first set included variables such as the location and size of the AO, movement of the DRA coordinating and control measures, duration of the battle phases, attrition and replacements, extent of war damage, and other dynamics of the scenario. The second set of variables, closely associated with the scenarios' terrain configuration and composition, included soil condition, slope, composition, and cover availability. Both variable sets were applied to each work category.

LODGEMENT PHASE TASKS AND INCREMENTS*

Increment G-1:

1   MSR Damage Repair
2   MSR Bridge Damage Repair
8   Division Airfield Damage Repair
18 EAD Ammunition Storage Site Preparation
24 POL Storage Site Preparation

Increment G-2:

4   MSR Bridge Maintenance Repair
5   MSR Improvement
6   Expedient Construction of MSR Bridges
7   Division Airfield Preparation
9   Division Airfield Maintenance Repair
14 Division CP & DISCOM Protective Construction
16 Division Signal Support
17 EAD Signal Support

Increment G-3:

3   MSR Routine Maintenance
10 Division Pioneer Access Road Construction
11 EAD Pioneer Access Road Construction
12 Division Pioneer Access Road Maintenance Repair
13 EAD Pioneer Access Road Maintenance Repair
15 Division CP & DISCOM Damage Repair
19 EAD Ammunition Storage Site Damage Repair

Increment G-3:--Continued

21 Division General Supply Site Damage Repair
23 EAD General Supply Site Damage Repair
25 POL Storage Site Damage Repair
26 Maintenance Unit Site Preparation
27 Maintenance Unit Site Damage Repair
28 EAD Support to Medical Activities
30 Terminate/Restore Utilities

Increment G-4:

20 Division General Supply Site Preparation
22 EAD General Supply Site Preparation
29 EPW Cage Site Preparation

*The arrangement of tasks within each increment has no significance. Figure F-1 lists of all the general engineering tasks.

Figure F-2

OFFENSE PHASE TASKS AND INCREMENTS*

Increment G-1:

1   MSR Damage Repair
2   MSR Bridge Damage Repair
10 Division Pioneer Access Road
    Construction
11 EAD Pioneer Access Road Con-
    struction
14 Division CP & DISCOM Protective
    Construction

Increment G-2:

8   Division Airfield Damage Repair
    (minimum air operating surface)
12 Division Pioneer Access Road
    Maintenance Repair
13 EAD Pioneer Access Road Mainte-
    nance Repair
18 EAD Ammunition Storage Site
    Preparation
21 Division General Supply Site
    Damage Repair
23 EAD General Supply Site Damage
    Repair
24 POL Storage Site Preparation
25 POL Storage Site Damage Repair
28 EAD Support to Medical Activi-
    ties

Increment G-3:

3   MSR Maintenance Repair
4   MSR Bridge Maintenance Repair
5   MSR Improvements (Dimensions/
    Surface)
6   Expedient Construction of MSR
    Bridges

Increment G-3:--Continued

7   Division Airfield Preparation
15 Division CP & DISCOM Damage
    Repair
16 Division Signal Support
17 EAD Signal Support
29 EPW Cage Site Preparation

Increment G-4:

9   Division Airfield Maintenance
    Repair (air operating surface)
19 EAD Ammunition Storage Site
    Damage Repair
20 Division General Supply Site
    Preparation
22 EAD General Supply Site Prep-
    aration
26 Maintenance Unit Site Damage
    Repair
27 Maintenance Unit Site Damage
    Repair
30 Terminate/Restore Utilities

*The arrangement of tasks within each increment has no significance.
Figure F-1 lists of all the general engineering tasks.

Figure F-3
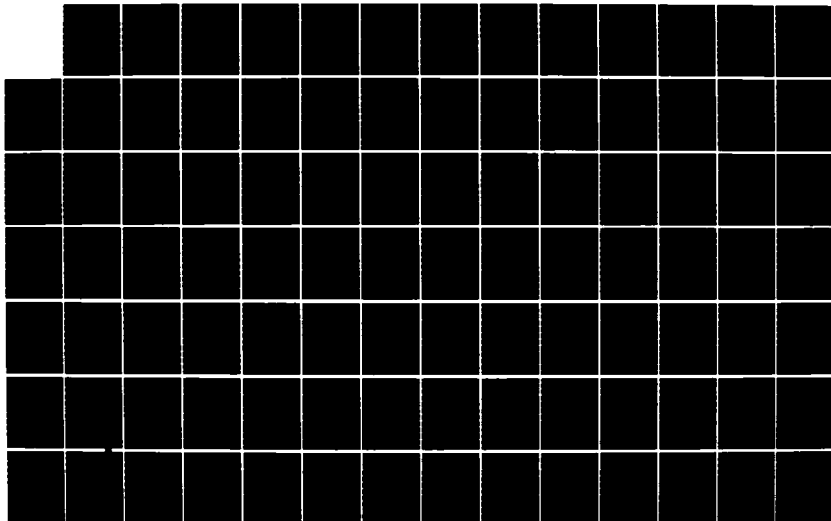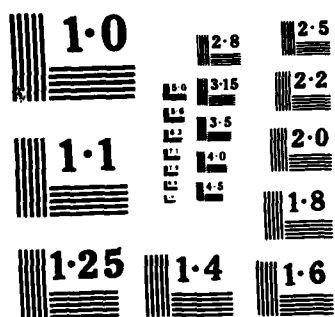
DEFENSE PHASE TASKS AND INCREMENTS*

Increment G-1:

1	MSR Damage Repair
2	MSR Bridge Damage Repair
14	Division CP & DISCOM Protective Construction
16	Division Signal Support
17	EAD Signal Support
28	EAD Support to Medical Activities

Increment G-2:

3	MSR Maintenance Repair
4	MSR Bridge Maintenance Repair
7	Division Airfield Preparation
8	Division Airfield Damage Repair (minimum air operating surface)
10	Division Pioneer Access Road Construction
11	EAD Pioneer Access Road Construction
15	Division CP & DISCOM Damage Repair

Increment G-3:

12	Division Pioneer Access Road Maintenance Repair
13	EAD Pioneer Access Road Maintenance Repair
18	EAD Ammunition Storage Site Preparation
24	POL Storage Site Preparation
25	POL Storage Site Damage Repair
26	Maintenance Unit Site Preparation
27	Maintenance Unit Site Damage Repair

Increment G-4:

5	MSR Improvement (dimensions/surface)
6	Expedient Construction of MSR Bridges
9	Division Airfield Maintenance Repair (air operating surface)
19	EAD Ammunition Storage Site Damage Repair
20	Division General Supply Site Preparation
21	Division General Supply Site Damage Repair
22	EAD General Supply Site Preparation
23	EAD General Supply Site Damage Repair
29	EPW Cage Site Preparation
30	Terminate/Restore Utilities

*The arrangement of tasks within each increment has no significance. Figure F-1 lists all the general engineering tasks.

Figure F-4

INCREMENT SUMMARY

Phase	Increment	Description
Lodgement	G-1	Repair major LOCs and protect important ammunition and POL sites
	G-2	Construct or repair secondary LOCs and important signal sites; protect important CPs
	G-3	Repair or maintain tertiary LOCs; repair or protect tertiary facilities
	G-4	Construct other needed facilities
Offense	G-1	Construct or repair major LOCs; protect important CPs
	G-2	Repair secondary LOCs; construct and repair secondary facilities
	G-3	Construct and repair tertiary LOCs and facilities
	G-4	Construct and repair other needed LOCs and facilities
Defense	G-1	Repair major LOCs and important signal sites; protect major facilities
	G-2	Construct and repair secondary LOCs; protect secondary facilities
	G-3	Repair tert'.ary LOCs; construct and repair tertiary facilities
	G-4	Construct and repair other needed LOCs and facilities

Figure F-5

GENERAL ENGINEERING FUNCTIONAL AREAS AND TASK NUMBERS*

Functional Area	Engineer Work Category**		
	Damage Repair	Expedient Construction	Maintenance Repair
MSRs	1	5	3
MSR Bridges	2	6	4
Army Airfields	8	7	9
Pioneer Roads--Division	--	10	12
Pioneer Roads--EAD	--	11	13
CP and Support Centers--Division	15	14	--
Signal Support--Division	15	16	--
Signal Support--EAD (CASC)	15	17	--
POL Sites	25	24	--
Ammunition Sites--EAD	19	18	13
Hospitals--EAD	--	28	13
EPW Cages	--	29	--
General Supply--Division	21	20	12
General Supply--EAD	23	22	13
Maintenance Units--EAD	27	26	--
Utilities	30	--	--

*Each task number is defined in Figure F-1.
**Some tasks for different functional areas area combined because of their location or because similar work is required.

Figure F-6

GENERAL ENGINEERING WORKLOAD--SWA SCENARIO

Duration		Task		
From	Through	No.*	Effort by Task**	Quantity
D-18	D-4	2	Repair tunnel entrance (each)	1
		3	Maintain MSR--roads (km)	585
		4	Maintain MSR--bridges (m)	1097
		10	Construct pioneer roads--Division (km)	21
		11	Construct pioneer roads--EAD (km)	10
		12	..Maintain pioneer roads--Division (km)	40
		13	Maintain pioneer roads--EAD (km)	24
		14	Protect DISCOM and division CPs (shelters)	15
			(slots)	51
			(berms)	25
		17	Protect CASC (berms)	15
		18	Protect ammunition storage sites (berms)	21
		20	Protect supply storage sites--Division (berms)	5
		24	Protect 60,000-gal POL site (FSSP) (sites)	4
		28	Prepare CSH (27,250 m^2 each) (sites)	3
		29	Construct 250-man EPW cages	2
D-3	D-1	3	Maintain MSR--roads (km)	154
		4	Maintain MSR--bridges (m)	334
		12	Maintain pioneer roads--Division (km)	48
		13	Maintain pioneer roads--EAD (km)	30
		14	Protect DISCOM and divison CPs (shelters)	15
			(slots)	51
			(berms)	25
		16	Protect Division Signal Nodes (berms)	20
		17	Protect CASC (berms)	15
		20	Protect supply storage sites--Division (berms)	6
		22	Protect supply storage sites--EAD (berms)	5
		24	Protect 60,000-gal POL Site (FSSP) (sites)	4
		25	Protect maintenance units--EAD (berms)	1
H-Hour	H+11	2	Repair MSR bridge (construct bypass)	1
		3	Maintain MSR--roads (km)	69
		4	Maintain MSR--bridges (m)	334
		7	Construct airfield (324,000 sq ft each)	1
		10	Construct pioneer roads--Division (km)	22
		11	Construct pioneer roads--EAD (km)	9
		12	Maintain pioneer roads--Division (km)	8
		13	Maintain pioneer roads--EAD (km)	5
		14	Protect division CPs (slots)	16
			(berms)	16
		16	Protect division signal nodes (berms)	20
		17	Protect CASC (berms)	30
		18	Protect ammunition storage site (berms)	3
		19	Repair damage to ammunition site (berms)	1

Figure F-7 (Continued on Next Page)

GENERAL ENGINEERING WORKLOAD--SWA SCENARIO--Continued

Duration		Task		
From	Through	No.*	Effort by Task**	Quantity
		25	Repair damage to POL storage site (berms)	2
		28	Prepare CSH site 27,250 m^2 each)	1
		30	Restore utilities--replace transmission line	1
H+12	H+35	3	Maintain MSR--roads (km)	138
		4	Maintain MSR--bridges (m)	305
		5	Construct MSR--roads (km)	6
		7	Construct airfield (324,000 sq ft each)	1
		10	Construct pioneer roads--Division (km)	21
		11	Construct pioneer roads--EAD (km)	3
		12	Maintain pioneer roads--Division (km)	16
		13	Maintain pioneer roads--EAD (km)	10
		14	Protect DISCOM and division CPs (shelters)	30
			(slots)	101
			(berms)	50
		18	Protect ammunition storage sites (berms)	11
		19	Repair damage to ammunition site (berms)	1
		20	Protect supply storage sites--Division (berms)	6
		22	Protect supply storage sites--EAD (berms)	5
		25	Repair damage to POL site (berms)	1
		26	Protect maintenance units--EAD (berms)	1
		28	Prepare CSH sites (27,250 m^2 each)	2
H+36	H+59	3	Maintain MSR--roads (km)	138
		4	Maintain MSR--bridges (m)	123
		10	Construct pioneer roads--Division (km)	21
		11	Construct pioneer roads--EAD (km)	3
		12	Maintain pioneer roads--Division (km)	16
		13	Maintain pioneer roads--EAD (km)	10
		17	Protect CASC (berms)	20
		19	Repair damage to ammunition sites (berms)	2
		25	Repair damage to POL sites (berms)	4

*See Figure F-1 for task descriptions.
**Work effort covers the DRA, the BSAs, and the MSR in the DRA and to the BSAs.

Figure F-7

GENERAL ENGINEERING WORKLOAD--EUROPEAN SCENARIO

Duration		Task		
From	Through	No.*	Effort by Task**	Quantity
D+29	D+42	29	Construct 250-man EPW cages	2
H-12	H+11	3	Maintain MSR--roads (km)	70
		4	Maintain MSR--bridges (m)	150
		10	Construct pioneer roads--Division (km)	16
		11	Construct pioneer roads--EAD (km)	4
		12	Maintain pioneer roads--division (km)	43
		13	Maintain pioneer roads--EAD (km)	16
		14	Protect DISCOM & CPs (shelters)	30
			(slots)	101
			(berms)	51
		15	Repair damage to DISCOM & CPs (shelters)	2
			(slots)	2
			(berms)	2
		16	Protect division signal nodes (berms)	20
		18	Protect ammunition storage sites (berms)	14
		19	Repair ammunition storage site (berms)	1
		20	Protect supply storage sites--division	7
		22	Protect supply storage site--EAD (berms)	2
		24	Protect 60,000-gal POL sites (FSSP) (sites)	6
		25	Repair damage to POL sites (berms)	3
H+12	H+35	2	Repair MSR--bridges (bypass on alternate route)	1
		3	Maintain MSR--roads (km)	70
		4	Maintain MSR--bridges (m)	150
		8	Repair airfield (MAOS) (craters)	1
			(spalls)	7
		9	Maintain airfield (AOS--MAOS) (craters)	2
			(spalls)	33
		10	Construct pioneer roads--division (km)	14
		11	Construct pioneer roads--EAD (km)	2
		12	Maintain pioneer roads--division (km)	43
		13	Maintain pioneer roads--EAD (km)	8
		15	Repair damage to DISCOM & CPs (shelters)	2
			(slots)	2
			(berms)	2
		16	Protect division signal nodes (berms)	20
		19	Repair damage to ammunition site--EAD (berms)	2
		25	Repair damage to POL site (berms)	2
H+36	H+47	2	Repair MSR--bridges (bypass on alternate route)	1
		3	Maintain MSR--roads (km)	72
		4	Maintain MSR--bridges (m)	63
		7	Construct airfield (324,000 sq ft each)	1
		10	Construct pioneer roads--division (km)	16
		11	Construct pioneer roads--EAD (km)	2
		12	Maintain pioneer roads--division (km)	23
		13	Maintain pioneer roads--EAD (km)	8
		14	Protect DISCOM & CPs (shelters)	30
			(slots)	101
			(berms)	50
		15	Repair damage to DISCOM & CPs (shelters)	2
			(slots)	2
			(berms)	2
		18	Protect ammunition storage site (berms)	7
		19	Repair damage to ammunition site (berms)	1
		20	Protect supply storage site--division (berms)	4
		21	Repair damage to supply sites--division (berms)	1
		22	Protect supply storage sites--EAD (berms)	2
		24	Protect 60,000-gal POL sites (FSSP) (sites)	4
		25	Repair damage to POL sites (berms)	2

*See Figure F-1 for task descriptions.

**Work effort covers the DRA, the BSAs, and the MSR in the DRA and to the BSAs.

Figure F-8

(1) Estimate damage repair requirements. Before the engineer effort needed to complete damage repair tasks can be assessed, the amount of damage expected to result from bombing, strafing, and sabotage against the 9ID(MTZ) installations must be estimated.

(a) To obtain estimates of bomb damage for the European and SWA scenarios, time-phased factors were used to compute enemy damage to friendly installations and facilities. These data were generated from the AFPDA[2] in both scenarios.

(b) ESC postulated different degrees of sabotage threat to the 9ID(MTZ) for each scenario and generated estimates for sabotage damage repair. The frequency and type of targets presumably being attacked in each scenario were estimated based on information in the AFPDA and the Middle East III scenario.[3]

(c) After bomb and sabotage damage levels were determined, the total US engineer requirements for damage repair were reduced by an amount equal to the HNS available in each scenario. These data were obtained from the AFPDA and modified by ESC to include estimates derived during ESC's earlier work on similar topics.

(2) Estimate expedient construction requirements. The scope of each expedient construction task was determined based mainly on the dimensions of the tactical situation, frequency of relocations, 9ID(MTZ) unit strength.

(a) The dimensions of the tactical situation vary by period for each scenario. Since many tasks use these dimensions as a basis for work requirements, ESC calculated the rear area dimensions for each period and

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[2]DA, OSCA, CAA, Army Force Planning Data and Assumptions, FY 1986-1994, (AFPDA 86-94) (U) (hereafter referred to as AFPDA).
[3]USACAC, CACDA, Middle East III--Operational Scenario (U).

scenario. These calculations include linear dimensions (such as route or bridge lengths) as well as volumetric (such as POL allocations) and a real (such as airfield) dimensions. (Volume II of this study describes the dimensions of the coordinating and control measures for each scenario and period.)

(b) Expedient construction is required each time divisional headquarters, CPs, and support commands are relocated. The frequency of unit relocation was driven by each scenario. The frequency of these relocations for each scenario and period of the battle phases was used in calculating engineer work requirements for the 30 general engineering tasks identified for the 9ID(MTZ).

(c) The 9ID(MTZ) unit strength was driven by the scenario. That information was used to determine required stockage levels of POL, ammunition, and other supplies. This, in turn, allowed ESC to calculate protective construction requirements.

(d) The difference between the percentage of HNS and allied support available for expedient construction tasks and the total requirement was calculated and used to determine the amount of expedient construction to be done by US engineers.

(3) Estimate maintenance repair requirements. Road networks and airfield surfaces deteriorate over time. This deterioration process is accelerated by constant daily use and adverse weather. Maintenance repair is required after a time to keep LOCs and facilities open. For airfields, the MAOS is opened to full runway capacity. Workload estimates were based on a percentage of road net in use or of the original expedient construction planning factor.

d. Step 4: apply workload factors and calculate requirements. After the general engineering tasks in each work category were quantified and adjusted to reflect the special conditions of the scenarios considered by this analysis, those requirements were applied to workload planning factors to determine the overall general engineering effort required to complete general engineering tasks included under each increment of each scenario. These workload planning factors, expressed as equipment-hours and manhours, were derived from ESC's interviews at Fort Lewis and standard engineer references, such as E-FOSS.[4]

e. Summary. Figure F-9 graphically summarizes the steps taken to obtain the general engineering requirements.

4. Basis for Planning Factor Estimates.

a. Damage repair. The AFPDA document gives a significantly low estimate for the percentage of damage sustained by friendly facilities in SWA. The estimate for the European scenario is only slightly higher. Figure F-10 shows ESC's estimate of targets hit by enemy sabotage and bombing for both scenarios. (Note that only seven of the 10 functional areas under damage repair are represented in Figure F-10.) The planning factors used to determine the general engineer requirements for damage repair are listed in Figure F-11.

(1) Task 2. US engineers will not repair the bomb-damaged bridges in the DRA. In each scenario, damaged spans destroyed by saboteurs are repaired through HNS. A review of the terrain analyses based on classified overlays of the scenario AO indicated that bypassing the damaged bridges

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[4]DA, USAES, DCD, Engineer Family of Systems Study (E-FOSS) (hereafter referred to as E-FOSS).

GENERAL ENGINEERING REQUIREMENTS METHODOLOGY
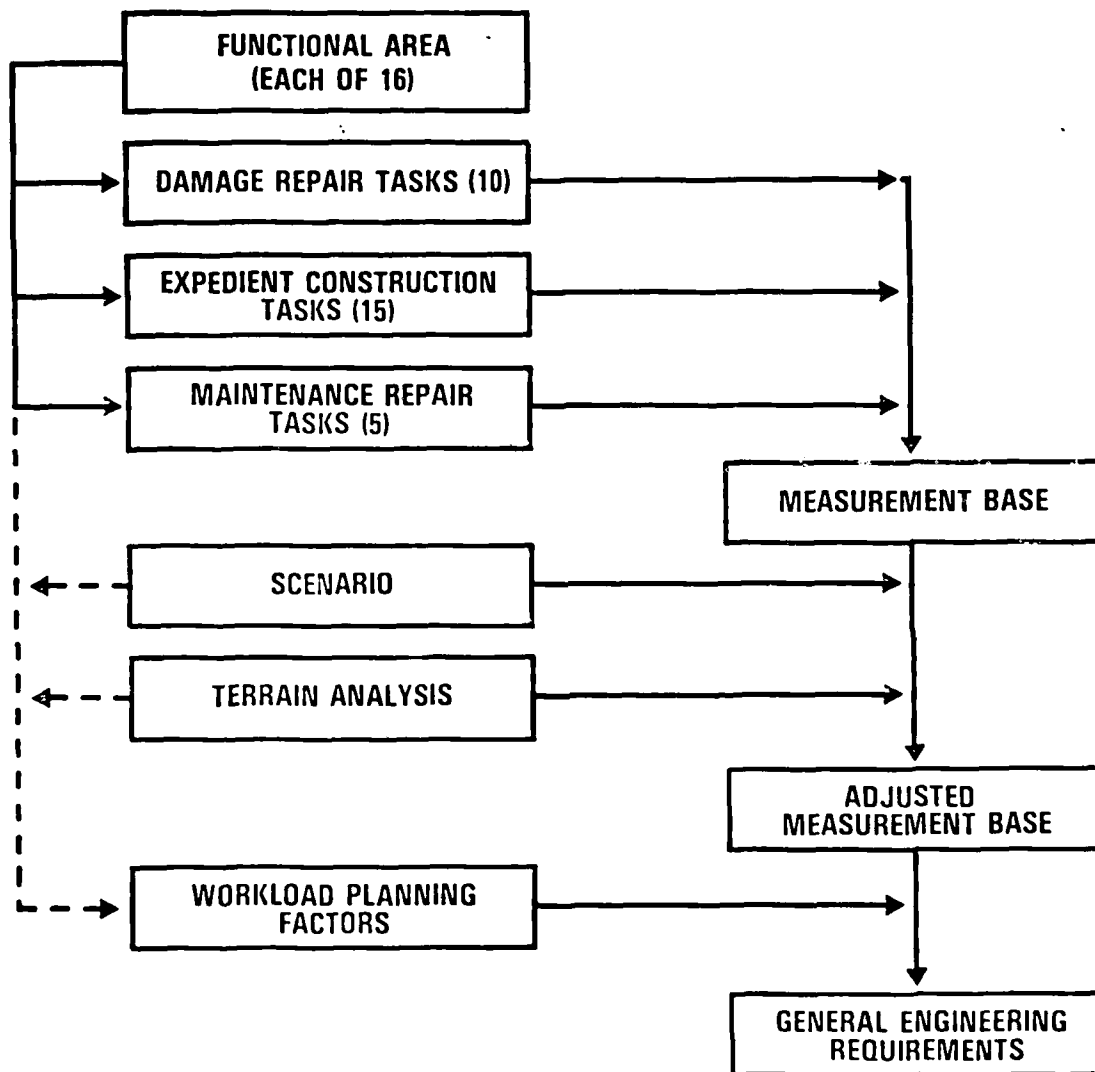
Figure F-9

TARGETS HIT BY ENEMY BOMBING AND SABOTAGE

Task No.[a]	Target Category	Bombing[b]		Sabotage[c]	
		SWA	Europe	SWA	Europe
2	MSR bridges			1	1
	(Tunnel)			(1)	
	Stockage sites				
25	POL		6	5	12
19	Ammunition	3	3	1	1
21, 23	General Supplies		1		
15	DISCOM and CPs		6		
30	Utilities				
	(Hydroelectric transmission lines)			1	
8	Army airfields[d]		1		

[a]See Figure F-1 for description of tasks.
[b]AFPDA and ESC estimates.
[c]DA, USACE, ESC, Analysis of III Corps Combat Engineer Wartime Requirements (U), and DA, CACDA, Middle East III-Operational Scenario (U), Volume I.
[d]Includes both general purpose bombs and cluster bomb units.

Figure F-10

DAMAGE REPAIR PLANNING FACTORS

Task No.[a]	Tasks	Man-Hours	Equipment-Hours ACE	Loader	Grader	Truck	SEE
2	Construct bridge bypass[b,c]						
	(within 1 km of damaged bridge)	1.8	1.9				
	Repair tunnel entrance[d,e]	33.4	5.2	2.5			
8	Repair airfield (MAOS/air attack)						
	0.5 craters [d,e]	5.4	1.7	1.1	0.3	1.1	
	6.8 spalls[e]	5.4				0.2	
	UXO[e]	0.1					
	Clear debris[e]	0.1				2.1	
15	Repair DISCOM facilities & CPs:[d]						
	Shelters (16 x 11 x 7 ft)	26.6		1.4		4.2	
	Slots (3.5 x 50 x 2 m)		0.1	0.2			
	Berms (6 x 14 x 160 ft)		0.4				
	Repair destroyed stockage site:						
19	Ammo berm (47 x 47 x 5 ft)[d]	0.4	5.0				
21	Supply berm (47 x 47 x 5 ft)[d]	0.4	5.0				
25	POL berm (39 x 39 x 6 ft)[c]	0.4	5.0				
30	Restore transmission line[d,f]	11.8				1.5	

[a]See Figure F-1 for a description of each task.
[b]HNS available for bridge repair during European scenario.
[c]E-FOSS estimate.
[d]Modified E-FOSS estimate.
[e]ESC's estimate.
[f]DA, TM 5-765, Electric Power Transmission and Distribution.

Figure F-11

is relatively easy. In fact, only minimal effort is needed to construct a temporary bypass within 1 km of the MSR bridge. The E-FOSS estimates indicate the number of man- and equipment-hours needed to complete this task, which amounted to preparing a 2-m bank on each side of the crossing point and putting in 50 m of road to each bank. During the lodgement phase of the SWA scenario, one tunnel is damaged by saboteurs. The E-FOSS estimates for individual tasks were expanded to include the wider range of work required to reopen the tunnel entrance (see Task 2, Figure F-11). The actual work involves blasting large boulders in place, removing 420 m^3 of debris along a 60 x 7-m stretch of highway, and repairing 5 m of roadway.

(2) Task 8. The 9ID(MTZ) will have either one or two medium-lift airfields in the DRA, depending on the scenario. Airfield damage repair requirements are estimated based on the probable damage caused by a one-aircraft, nine-bomb attack. The MAOS of a damaged medium-lift airfield must be repaired. Fifteen percent of the damage to the airfield is expected to be on the MAOS (2,000 x 60 ft), which places it in the damage repair category. The remaining 85 percent of the damage is expected to occur on the AOS, so it is considered part of the the routine maintenance category. Task 8 mainly consists of clearing debris, filling and grading craters and spalls, and helping EOD teams expose UXO.

(3) Task 15. Damaged and destroyed CP and DISCOM protective structures must be repaired or replaced. The damage to these facilities is assumed to be only from enemy air attacks. Because of the larger division area and the greater distance enemy aircraft must fly over friendly open terrain to get to the DISCOM and CPs in the SWA scenario, and because of the stronger enemy air threat in the European scenario, ESC assumed that CPs and

DISCOM facilities would sustain much more bomb damage during the European scenario. The degree of damage is assumed to be moderate to these structures. E-FOSS provided the base estimates for the factors ESC used to calculate the general engineering workload estimates for reconstructing shelters and repairing slots and berms.

(4) Tasks 19, 21, 25. During both scenarios, enemy air attacks and sabotage damage berms at both the ammunition and POL storage sites within the DRA and BSAs. Based on the AFPDA document and previous ESC studies, it was estimated that far more enemy attacks would be made against these sites than against general supply storage sites, which experience only one hit during the European scenario and none during the SWA scenario. Each POL storage site is comprised of six 10,000 gallon POL bladders, eight of which are located in the division AO (three in the brigade areas and five in the DRA). Each bladder is bermed to specific dimensions. The ammunition and general supply storage sites are also bermed, but to different dimensions. The AFPDA estimates a greater threat of damage from saboteurs and enemy aircraft to POL sites than to ammunition sites, and a far greater threat to both of these than to general supply storage sites.

(5) Task 30. While the utilities infrastructure for the European scenario is very extensive and redundant, the utilities network in the SWA scenario is limited and sparse. ESC assumed that saboteurs pose a threat to transmission lines in both scenarios, but that repair work will be done only to the damaged or destroyed lines during the SWA scenario. This is because the SWA scenario has a less extensive system with virtually no back-up capability. Other utilities were also considered, but none created a general engineering requirement within the scope of this study. To restore electrical

power under the SWA scenario, two utility poles will have to be installed, along with 75 ft of three-conductor (230 VAC) wire and a 3 to 25 KVA transformer.

   b. Expedient construction. Figure F-12 lists the planning factors ESC used to determine the general engineering requirements for expedient construction.

   (1) Task 5. Construction of 6 km of the MSR road in the SWA scenario was necessary in order to bypass a congested built-up area in the DRA. This task was completed during Period 4 of the battle, when the division rear boundary was relocated several kilometers to the rear.

   (2) Task 7. The 9ID(MTZ) plans to have two operational medium-lift airfields in the DRA during the SWA scenario and one during the European scenario. Each scenario dictates that one of these airfields be built during the later stages of battle, when the division rear boundary is relocated to the rear. The planning factors are derived from AFM 86-3,[5] which lists work effort estimates for laying M-19 matting. ESC assumed a medium-lift, unpaved airfield suitable for C-130H aircraft at maximum gross weight.

   (3) Tasks 10 and 11. Pioneer roads were estimated to be required by 20 divisional and 8 to 12 EAD companies. These roads are an average of 2 km long per company. In addition, pioneer roads are required in conjunction with other expedient construction. These estimates are included within the total planning factor. It was determined that 60 and 80 percent of the pioneer roads required during the SWA and European scenarios, respectively, were already in place and usable. (Figures F-7 and F-8 show the quantities required.)

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[5]USAF, AFM 86-3, Planning and Design of Theater of Operations Air Bases.

EXPEDIENT CONSTRUCTION PLANNING FACTORS

Task No.[a]	Tasks	Man-Hours	Equipment-Hours				
			ACE	Loader	Grader	Truck	SEE
5	Construct new MSR (per km)[b]	1722.0	900.0	225.5	190.0	438.0	375.0
7	Construct airfield (324,000 sq ft of M-19 matting)[c]	925.7			2.2		
10/11	Construct pioneer roads[b] (per km)	11.4	11.4				
14	Construct DISCOM facilities & CPs[b]						
	Shelters (16 x 11 x 8 ft)	266.0		14.0		42.0	
	Slots (3.5 x 50 x 2 m)		0.8	1.7			
	Berms (6 x 14 x 160 ft)		4.0				
16/17	Construct communication facilities[b]						
	Slots (3.5 x 50 x 2 m)		0.8	1.7			
18	Construct ammunition storage site[d]						
	Berms (5 x 47 x 47 ft)	0.7	5.4				
20/22	Construct storage site						
	Supply site berms (47 x 47 x 5 ft)[d]	0.7	5.4				
24	POL berm (39 x 39 x 6 ft)[b]	0.7	5.4				
26	Class IX berms (47 x 47 x 5 ft)[d]	0.7	5.4				
28	Construct CSH site (27,250 m^2)[b]						
	Site clearance	33.0	110.5				
	Site drainage				4.1		
	Sanitation pits	15.3	5.7			15.3	15.3
29	Construct 250-man EPW cage[d,e]						
	2400-m concertina wire	240.0				3.0	
	500-m access road	17.1	17.1				

[a]See Figure F-1 for a description of each task.

[b]E-FOSS estimate.

[c]USAF, AFM 86-3, Planning and Design of Theater of Operations Air Bases and DA, TM 5-330, Planning and Design of Roads, Airbases, and Heliports in Theater of Operations.

[d]Modified E-FOSS estimate.

[e]Department of the Army, Field Manual, FM 5-35, Engineers' Reference and Logistical Data; TM 5-765, Electric Power Transmission and Distribution; FM 19-40, Enemy Prisoners of War; FM 101-10-1, Staff Officer's Field Manual: Organizational, Technical, and Logistic Data.

Figure F-12

(4) Task 14. Protection requirements for the DISCOM and division CPs were estimated based on the 9ID(MTZ)'s TOE. The measurement base is derived from the actual unit locations and relocations in each scenario.

(5) Tasks 16 and 17. To determine the engineer effort required to protect the vehicles within each communications node and CASC, the TOE was reviewed to identify the number of slots planned for each location and relocation. The E-FOSS estimate for this task was used in calculating the general engineering workload factor used in this analysis.

(6) Tasks 18, 20, 22, 24, and 26. Storage site protective construction for ammunition, general supplies, POL, and Class IX involves the use of berms in various shapes and sizes. ESC estimated the average supply rates for each class of supplies considered in the task list (Figure F-1). The 3-day supply rate for the 14,500-man division was calculated and the volume of supplies in each class was determined in order to estimate the size and number of berms required to protect those supplies.

(7) Task 28. One CSH and one EH were located in the DRA throughout the SWA scenario. The amount of work required for the EH is twice the requirements of the CSH. The factors for this task listed in Figure F-10 are from E-FOSS and based on the hospital site reparation data found in FM 5-35, Engineer's Reference and Logistical Data.

(8) Task 29. Based on the data from FM 101-10-1, Staff Officers FM Organizational, Technical and Logistic Data, ESC estimated that 500 and 300 EPWs are evacuated to division EPW cages during the SWA and European scenarios, respectively.

c. Maintenance repair. As the infrastructure of the division AO experiences an accelerated deterioration, such elements as road networks and

airfields must be repaired and maintained at a serviceable level. To keep these LOCs open requires a certain minimum amount of daily maintenance. Figures F-7 and F-8 listed the data used to calculate the measurement base for maintenance repair. Figure F-13 shows the planning factors used to determine the maintenance repair requirements. The particular considerations for the workload factors covering the expedient construction work category are:

(1) Task 3. During each scenario, a certain length of MSR roads must be maintained daily. These distances are measured from the primary or secondary DISCOM area to the BSA in each brigade. In both scenarios, it was assumed that asphalt application is either not possible or practical in the very short time allowed during each period of battle. Repair estimates include clearing debris and filling areas of damaged roadway with crushed rock.

MAINTENANCE REPAIR PLANNING FACTORS

Task No[a]	Tasks	Man-Hours	Equipment			
			ACE	Loader	Grader	Truck
3	Maintain MSR roads (100 km/day)[b,c]	100.0			20.0	20.0
4	Maintain MSR bridges (per m/day)[d]	1.0			0.2	0.2
9	Maintain airfield (MAOS - AOS)					
	Repair 2.3 craters/air attack[d,e]	27.6	8.7	5.6	1.5	5.6
	Repair 33.8 spalls/air attack[d]	26.8				1.0
	Repair 0.8 UXO/air attack[d]	0.8				
	Clear debris[d]	0.5			2.1	
12/13	Maintain pioneer roads (per km/day)[b]	1.0		0.1	0.3	0.3

[a]See Figure F-1 for a description of each task number.
[b]E-FOSS estimate.
[c]TM 5-765, Electric Power Transmission and Distribution.
[d]ESC's estimate.
[e]Modified E-FOSS estimate.

Figure F-13

(2) Task 4. The engineer effort required to complete this task was based on total lengths of MSR bridges for each period and scenario. Surface deterioration on the bridges occurred primarily at the approach ends during both scenarios. This is where the bulk of repair work must be done. For longer spans, a small amount of effort (5 percent) is expended repairing expansion joints. In both cases, only crushed rock is used as the repair medium.

(3) Task 9. During each scenario, one or two medium-lift airfields are maintained in the DRA. The AOS of each airfield is kept operational. This means damage to the MAOS must be repaired and that the remainder of the AOS, pioneer roads, and other facilities must be given a minimum level of maintenance repair. Because of the short battle phases in both scenarios, ESC estimates that no maintenance repair work is necessary to both AOS, except when it is bombed during the European secnario (see Figure F-10). About 85 percent of the repair work to the AOS is maintenance repair. (The estimate of the work required to do maintenance repair to the air field pioneer roads maintenance repair is made seperately under task 12.

(4) Tasks 12 and 13. Although more than half of the pioneer roads required in the DRA already exist, maintenance repair requirements for these tasks include the entire pioneer road network in each scenario. The length of these networks was determined for each period of battle for each unit requirement. The measurement base is the number of companies and storage or facility sites which are not totally mobile and which are located behind the brigade rear boundaries or BSAs. Each supported division and EAD company and the DISCOM requires an average of 2 km of pioneer road maintenance per location. Each CSH, EPW cage site, and division airfield requires 0.5 km of

pioneer roads per location. Each POL, ammunition, and supply storage site requires 200 m of pioneer roads. These factors are listed in Figures F-7 and F-8.

5. Results.

a. After considering all aspects of the tactical situation in each scenario, the terrain analyses for each AO, and the various DOD planning data, it was determined that some of the tasks listed in Figure F-1 are not required during one or both of the scenarios. Figure F-14 lists which tasks were not required, and gives a brief explanation of why they were omitted from this analysis.

b. Figures F-15 through F-18 summarize the general engineering requirements for each increment and scenario. These requirements are subdivided into unit areas and periods of battle. The total general engineering requirements are separated into division-only requirements (Case I for this analysis) and EAD requirements (Case II). Division requirements are broken down by unit area; EAD requirements are combined for all unit areas.

6. Observations.

a. A 6-km MSR bypass around a small town is an essential priority task that occurs during Period 4 of the SWA scenario. It would take 10,332 manhours and 12,768 equipment-hours to build that bypass. If suitable alternate routing were available (which was not the case in this scenario), or if the chances of traffic constriction into and out of the town were minimal, then a tremendous amount of general engineering effort could be saved. Expedient MSR construction is normally conducted over days and weeks unlike the 24 hours allocated in the SWA scenario.

b. The location of the lodgement area in the SWA scenario is 585 km to the rear of the division AO. Since there is no other support to help the

GENERAL ENGINEERING TASKS NOT REQUIRED BY EITHER SCENARIO

Task No.*	Tasks Not Performed	Reasons	Scenario SWA	Europe
1	MSR damage repair	Low damage estimate (AFPDA)	X	
		Easy bypass/alternate route	X	X
5	MSR improvements	MSR is adequate and extensive		X
6	MSR bridge construction	MSRs have adequate bridges	X	X
8	Airfield damage repair (MAOS)	Low damage estimate (AFPDA)	X	
15	DISCOM & CP damage repair	Low damage estimate (AFPDA)	X	
		Low sabotage estimate (ESC)	X	
17	CASC protective construction	No CASC units in division AO		X
21	Supply site damage repair (division)	Low damage estimate (AFPDA)	X	
		Low sabotage estimate (ESC)	X	
23	Supply site damage repair (EAD)	Low damage estimate (AFPDA)	X	
		Low sabotage estimate (ESC)	X	
		Low unit density	X	X
26	Protect maintenance units	No maintenance units in AO		X
27	Repair maintenance unit site	Low damage estimate (AFPDA)	X	
		Low unit density	X	
		No maintenance units in AO		X
28	Support medical facilities	No medical facilities in AO		X
30	Terminate/restore utilities	Infrastructure extensive with numerous redundancies		X

*See Figure F-1 for task description.

Figure F-14

GENERAL ENGINEERING REQUIREMENTS--INCREMENT G-1

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*

SWA Scenario

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*
D-18	D-4	Squad	3.0	3.0	3.0	15.0	1.2
		ACE	16.2	16.2	16.2	81.0	113.4
D-3	D-1	Squad				572.9	0.1
		ACE				186.4	14.2
		Loader				331.2	25.2
		5-Ton Truck				630.0	
H-Hour	H+11	Squad				26.4	14.6
		ACE				286.5	102.6
		Loader				54.4	
H+12	H+35	Squad				1145.1	15.4
		ACE				334.4	240.0
		Loader				595.1	
		5-Ton Truck				1260.1	30.6
		Grader					8.2
		SEE					30.6
H+36	H+59	Squad					0.1
		ACE					27.5
		Loader					50.4

European Scenario

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*
D+29	D+42	(None)				1145.4	
H-12	H+11	Squad				353.6	
		ACE				628.7	
		Loader				1260.7	
		5-Ton Truck				2.1	
H+12	H+35	Squad				132.8	
		ACE				88.8	
		Loader				1145.4	
H+36	H+47	Squad				334.4	
		ACE				595.1	
		Loader				1260.0	
		5-Ton Truck					

*All unit areas combined.

Figure F-15

GENERAL ENGINEERING REQUIREMENTS--INCREMENT G-2

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*
			SWA Scenario				
D-18	D-4	Squad				577.3	0.2
		ACE				167.2	13.3
		Loader				297.6	25.2
		Grader				6.6	
		5-Ton Truck				636.6	
D-3	D-1	Squad				67.4	
		Grader				94.4	
		5-Ton Truck				94.4	
H-Hour	H+11	Squad				2.9	9.7
		ACE			5.0	10.0	136.2
		Loader				2.0	1.2
		Grader				6.0	7.7
		5-Ton Truck				6.0	18.9
		SEE					15.3
H+12	H+35	Squad				158.1	3.0
		ACE				34.2	21.0
		Grader				29.4	
		5-Ton Truck				31.6	
H+36	H+59	Squad				25.2	2.9
		ACE				34.2	20.0
		Grader				28.4	
		5-Ton Truck				28.4	
			European Scenario				
D+29	D+42	(None)				91.2	6.5
H-12	H+11	Squad				55.2	45.6
		ACE				31.4	
		Loader				12.1	
		Grader				96.1	
		5-Ton Truck				89.9	
H+12	H+35	ACE				89.9	3.3
		ACE				34.1	22.8
		Loader				32.5	
		Grader				14.5	
		5-Ton Truck				97.4	
H+36	H+47	Squad				215.9	3.3
		ACE				32.4	22.8
		Loader				31.4	
		Grader				8.4	
		5-Ton Truck				90.2	

*All unit areas combined.

Figure F-16

GENERAL ENGINEERING REQUIREMENTS--INCREMENT G-3

Duration		Effort	Division Requirements					EAD
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	CBAA	DRA	Requirements
			SWA SCENARIO					
D-18	D-4	Squad				--	560.5	43.9
		ACE				--	195.8	469.4
		Loader				--	6.0	3.6
		Grader				--	720.0	23.1
		5-Ton Truck				--	722.0	56.7
		SEE				--		45.9
D-3	D-1	Squad	3.0	3.0	3.0	--	23.6	5.2
		ACE	16.2	16.2	16.2	--	81.0	5.4
		Loader				--	6.0	3.6
		Grader				--	18.0	10.8
		5-Ton Truck				--	18.0	10.8
H-Hour	H+11	Squad				--	138.9	0.3
		ACE				--	19.2	27.5
		Loader				--	33.5	50.4
		Grader				--	11.1	
		5-Ton Truck				--	8.9	
H+12	H+35	Squad				--	5.8	4.2
		ACE				--	10.8	16.2
		Loader				--	4.0	2.4
		Grader				--	12.0	7.2
		5-Ton Truck				--	12.0	7.2
H+36	H+59	Squad				--	5.8	3.4
		ACE				--	5.4	
		Loader				--	4.0	2.4
		Grader				--	12.0	7.2
		5-Ton Truck				--	12.0	7.2
			European Scenario					
D+29	D+42	(None)						
H-12	H+11	Squad	6.0	6.1	6.0	--	17.7	3.1
		ACE	37.4	37.8	37.4	--	64.8	75.6
		Loader				--	4.0	1.6
		Grader				--	12.0	4.8
		5-Ton Truck				--	12.0	4.8
H+12	H+35	Squad				6.0	5.8	1.1
		ACE		5.0	5.0	32.4	5.4	
		Loader				--	4.0	0.8
		Grader				--	12.0	2.4
		5-Ton Truck				--	12.0	2.4
H+36	H+47	Squad			0.1	--	26.9	37.8
		ACE	5.0	5.0	5.4	--	129.6	37.8
		Loader				--	2.0	0.4
		Grader				--	6.0	1.2
		5-Ton Truck				--	6.0	1.2

*All unit areas combined.

Figure F-17

GENERAL ENGINEERING REQUIREMENTS—INCREMENT G-4

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*

SWA Scenario

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*
D-18	D-4	Squad					0.5
		ACE				27.0	
D-3	D-1	Squad				7.0	0.5
		ACE				32.4	27.0
		Grader				13.5	
H-Hour	H+11	Squad				2.8	0.1
		ACE					5.4
		Grader				2.3	
		SEE				1.5	
H+12	H+35	Squad				1478.7	0.6
		ACE				5432.4	32.4
		Loader				1350.0	
		Grader				1144.5	
		5-Ton Truck				2628.0	
		SEE				2250.0	
H+36	H+59	Squad				2.1	0.1
		ACE					10.8
		Grader				4.5	

European Scenario

| Duration | | Effort | Division Requirements | | | | EAD |
From	Through	(Hours)	1st Bde	2d Bde	3d Bde	DRA	Requirements*
D+29	D+42	Squad				24.5	
		ACE				11.4	
		5-Ton Truck				2.0	
H-12	H+11	Squad				1.7	0.3
		ACE				37.8	15.2
		Grader				0.7	
		5-Ton Truck				0.7	
H+12	H+35	Squad				10.2	0.1
		ACE				8.3	10.8
		Loader				5.6	
		Grader				4.3	
		5-Ton Truck				7.5	
H+36	H+47	Squad				1.5	0.3
		ACE				27.0	16.2
		Loader				7.0	
		Grader				0.7	
		5-Ton Truck				0.7	

*All unit areas combined.

Figure F-18

division maintain the MSR during period 1 of the battle, 3,510 manhours and 1,404 equipment hours are taken from division assets to keep this length of road open during the lodgement phase (D-18 through D-4) the rear of the division AO. Since there is no other support to help the division maintain the MSR during Period 1 of the battle, 3,510 manhours and 1,404 equipment-hours are taken from division assets to keep this length of road open during the lodgement phase (D-18 through D-4).

     c. The size of the division AO in the SWA scenario is 8.4 times the size of the division AO in the European scenario. That creates additional general engineering requirements in the SWA scenario for EAD units located in the DRA, such as three CSHs, one CASC, and one maintenance company. None of these units are found in the smaller DRA of the European scenario.

     d. The SEE has general engineering utility only in the SWA scenario. The tasks involving the use of the SEE for general engineering are the construction of an MSR bypass. None of these tasks are performed during the European scenario.

LAST PAGE OF ANNEX F

ANNEX G

ENGINEER CLASS IV AND V REQUIREMENTS

ANNEX G

ENGINEER CLASS IV AND V REQUIREMENTS

1. _Purpose._ This annex describes the methodology ESC used to estimate the Class IV and V requirements needed to support the 9ID(MTZ) during the SWA and European scenarios.

2. <u>Scope</u>. This analysis calculated requirements for those Class IV and V items used by the divisional engineers for mobility and countermobility missions. It also quantified the artillery and aviation Class V mine expenditures, but did not analyze non-engineer haul capabilities.

3. <u>Limits</u>. The analysis in this annex is limited to the following issues:

a. Scenario-generated ASRs for scatterable mines, MICLICs, and M-180 cratering kits.

b. Class IV and V haul requirements for the divisional engineer battalion.

c. The distribution of engineer 5-ton cargo trucks associated with a dedicated mission (Volcano, MICLIC, or LAB).

d. The relative cost of the three mining systems available to the division in terms of C-141B sorties and minefield module equivalents.

4. <u>Assumptions and Their Significance</u>.

a. ASSUMPTION: The tonnage of the current ASRs for the 9ID(MTZ) is logistically supportable. SIGNIFICANCE: The recommended ASR modifications will vary significantly from those proposed in this annex if the division cannot be supplied with its projected tonnage of Class V stockage by theater transport assets.

b. ASSUMPTION: The PLS will be used in transporting Class IV and V items from the BSA forward to the user. SIGNIFICANCE: The PLS allows Class IV and V items to be transported in their shipping configuration. Without this system, Class IV and V items may be uncrated, increasing loading and unloading times, and generating a larger haul requirement due to the increased cargo volume.

5. *Methodology.*

    a. Class V analysis.

    (1) Mines.   Figure G-1 shows how ESC determined the mine requirements for each scenario. The countermobility methodology (Annex D) estimated the number of mines required to support the division's obstacle plans for the SWA and European scenarios. The division's capability to emplace minefields was a function of the current design ASR and the three types of dispensing systems available. In Case 1, that capability was not degraded; in Case 2, equipment losses lowered the division's overall capability. The comparison of capabilities versus requirements for each scenario indicated three areas where improvements could be implemented.

CLASS V METHODOLOGY
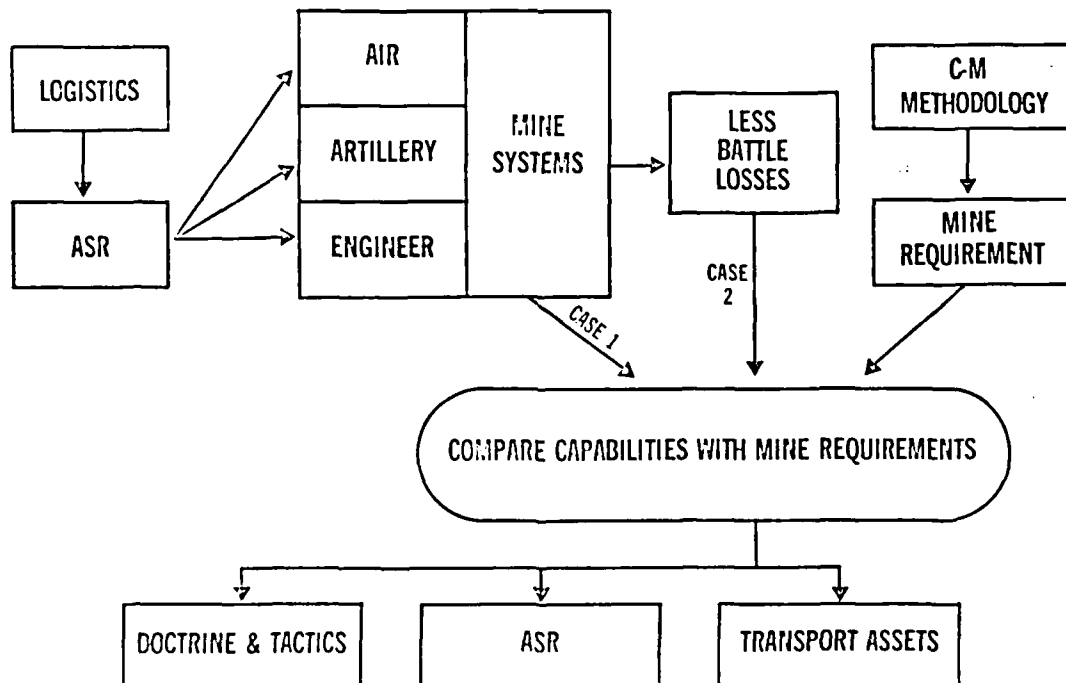
Figure G-1

(a) Although the division's doctrine and tactics are subject to change, ESC believes the 9ID(MTZ)'s concept of operations should dictate Class V usage and not the other way around. Only a severe Class V shortage would warrant a recommendation altering the division's tactics.

(b) The individual ASRs of the systems under analysis may be adjusted, depending on their overuse or underuse. But the net effect of the total adjustments must not increase the division's total daily Class V tonnage.

(c) Once the requirements for each scenario are established, the issue of transporting the Class V items to the user becomes a logical follow-on. This analysis looked only at the engineer Class V load and matched that load with the capability available within the divisional engineer battalion alone.

(2) Other key engineer munitions. With minor modifications, the methodology ESC devised to calculate mine requirements can be used for the analysis of the requirements of other Class V items such as the MICLIC and M-180 cratering kits. Figures G-2 and G-3 highlight the changes to the basic methodology, and show how ESC determined the MICLIC and M-180 requirements for the 9ID(MTZ) in each scenario.

b. Class IV. Figure G-4 shows how ESC estimated the requirements for tactical wire in support of the division's obstacle plan for both scenarios. Using the countermobility methodology, requirements for using concertina wire in tank ditches and as anti-vehicular obstacles were calculated. By comparing the engineer battalion's capability to haul Class IV items with its requirements to install wire obstacles, ESC was able to determine whether an excess or shortfall in capability existed. Improvements were suggested in the

G-4

CLASS V METHODOLOGY--MICLICs
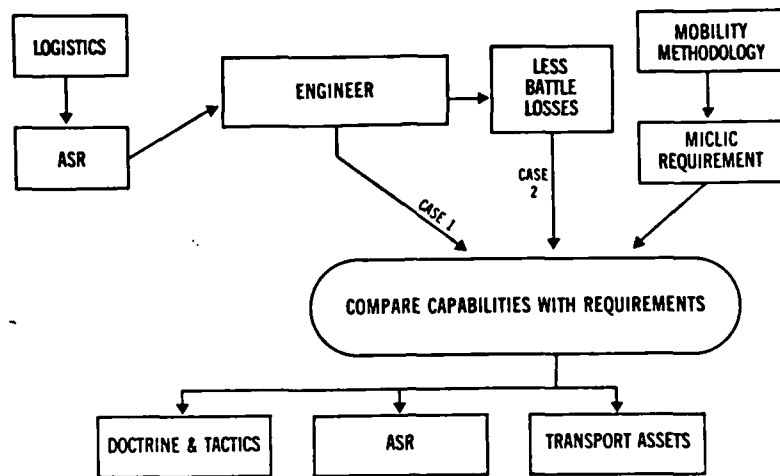
Figure G-2

·CLASS V METHODOLOGY--M-180
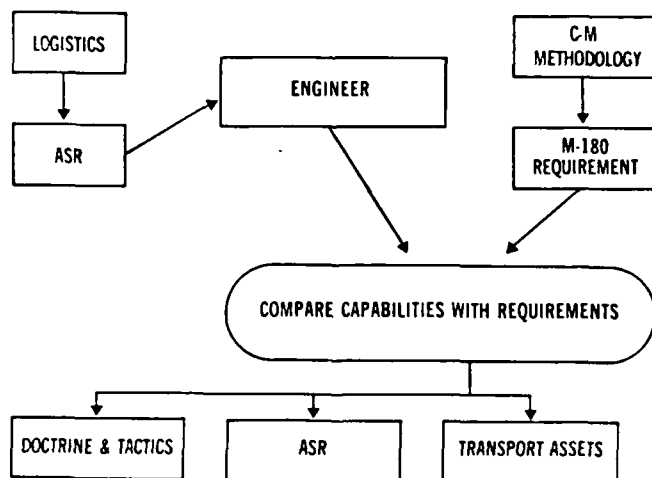
Figure G-3

same three areas as the Class V analysis plus a fourth area of technology. Since wire obstacles are logistically burdensome, ESC looked towards technology to provide the ideal combination of light weight, fast emplacement, and compact-volume obstacles that expands to an effective size on site.

CLASS IV METHODOLOGY
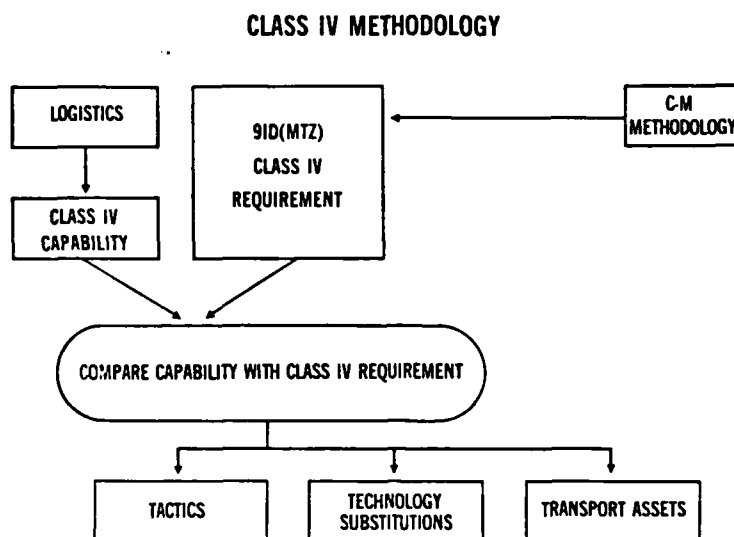
Figure G-4

6. <u>Results and Observations.</u>

    a. Key ASRs.

        (1) 1986 design TOE systems.

        (a) Figures G-5 through G-8 show the results of the ASR analysis, both Case 1 and Case 2, for the SWA and the European scenario. In both scenarios certain trends emerged. There were shortfalls in artillery-delivered antitank mines, MOPMS, and M-180 cratering kits, but excess capability in artillery-delivered anti-personnel mines, Air Volcano, and MICLICs. The Ground Volcano system was the only system for which requirements varied significantly with scenario. In the SWA theater, Ground Volcano requirements exceeded capability, while European requirements fell short of Ground Volcano

SWA ASR ANALYSIS--WITHOUT EQUIPMENT LOSSES
(Daily Average)

System	Current ASR	Capability	Require-ment	Difference	Recommended ASR	Change (Tons)
RAAM	32 rounds*	15,552 mines	19,438	-3,886	40 rounds	+24
ADAM	24 rounds*	46,656 mines	3,403	+43,253	3 rounds	-62
Ground Volcano	2,880 mines*	17,280 mines	19,724	-2,444	3,288	+10
Air Volcano	1,728 mines*	13,824 mines	9,530	+4,294	1,192	-17
MICLIC	10 each*	100 charges	32	+68	4	-93
MOPMS	110 boxes**	110 boxes	359	-249	359	+22
M-180	120 kits**	120 kits	447	-327	447	+27
Total Savings						-89

*Per system per day.
**Per battalion per day.

Figure G-5

SWA ASR ANALYSIS--WITH EQUIPMENT LOSSES
(Daily Average)

System	Current ASR	Capability	Require-ment	Difference	Recommended ASR	Change (Tons)
RAAM	32 rounds*	15,122 mines	19,438	-4,316	41 rounds	+27
ADAM	24 rounds*	45,367 mines	3,403	+41,964	3 rounds	-62
Ground Volcano	2,880 mines*	16,161 mines	19,724	-3,563	3,474	+14
Air Volcano	1,728 mines*	13,305 mines	9,503	+3,775	1,256	-15
MICLIC	10 each*	93 charges	32	+61	4	-93
MOPMS	110 boxes**	110 boxes	359	-249	359	+22
M-180	120 kits**	120 kits	447	-327	447	+27
Total Savings						-80

*Per system per day.
**Per battalion per day.

Figure G-6

EUROPEAN ASR ANALYSIS--WITHOUT EQUIPMENT LOSSES
(Daily Average)

System	Current ASR	Capability	Require-ment	Difference	Recommended ASR	Change (Tons)
RAAM	32 rounds*	15,552 mines	15,699	-147	33 rounds	+3
ADAM	24 rounds*	46,656 mines	3,224	+43,432	2 rounds	-65
Ground Volcano	2880 mines*	17,280 mines	9,600	+7,680	1,600	-31
Air Volcano	1,728 mines*	13,824 mines	7,142	+6,682	893	-26
MICLIC	10 each*	100 charges	60	+40	6	-62
MOPMS	110 boxes**	110 boxes	346	-236	346	+22
M-180	120 kits**	120 kits	1,009	-889	1,009	+73
Total Savings						-86

*Per system per day.
**Per battalion per day.

Figure G-7

EUROPEAN ASR ANALYSIS--WITH EQUIPMENT LOSSES
(Daily Average)

System	Current ASR	Capability	Require-ment	Difference	Recommended ASR	Change (Tons)
RAAM	32 rounds*	14,821 mines	15,699	-878	34 rounds	+6
ADAM	24 rounds*	44,453 mines	3,224	+41,229	3 rounds	-62
Ground Volcano	2,880 mines*	15,303 mines	9,600	+5,703	1,930	-23
Air Volcano	1,728 mines*	13,174 mines	7,142	+6,032	974	-24
MICLIC	10 each*	88 charges	60	+28	7	-46
MOPMS	110 boxes**	110 boxes	346	-236	346	+22
M-180	120 kits**	120 kits	1,009	-889	1,009	+73
Total Savings						-54

*Per system per day.
**Per battalion per day.

Figure G-8

capability. By adjusting the ASRs to the levels listed in the "Recommended" columns of Figures G-5 through G-8, the 9ID(MTZ) can meet the scenario-generated requirements for all seven systems and still not increase the daily weight for these Class V items above 470 tons. With equipment losses, the implementation of all the recommended ASR adjustments will produce a total shipment savings for the division of 80 tons (Figure G-6) and 54 tons (Figure G-8), respectively, for the SWA and European scenarios.

(b) The requirements of counterbattery artillery missions were not calculated as part of either the countermobility or the Class V methodology. This ASR analysis indicates that the excess capability in ADAM mines allows the ADAM ASR to be increased about 18 to 19 rounds per tube per day to compensate for counterbattery missions. Although this increase would eliminate the weight savings listed in Figures G-6 and G-8, the change would *not increase the 470-ton ceiling.*

(2) GEMSS excursion. The GEMSS and Volcano mine systems were compared to evaluate the impact of not fielding the Volcano systems. Figure G-9 shows the results, by scenario, of substituting the GEMSS system for both the Air and Ground Volcano. It is important to note that the GEMSS system does not have the flexibility nor the maneuverability of the Air Volcano system. Thus, it cannot replace Air Volcano minefields on a one-for-one basis. The first obvious effect is the loss of minefield capability in support of the division's counterattacks. Secondly, the number of squad-hours of effort required to emplace the minefields increases substantially (see Annex D). Finally, the substitution of GEMSS for both Volcano systems increases the daily Class V weight required (see Figure G-9). In SWA, the weight rises by almost 23 tons. In Europe, the GEMSS system provides a smaller savings to the division (21 tons) than that possible with both Volcano systems (46 tons).

G-9

GEMSS ASR EXCURSION--WITH EQUIPMENT LOSSES
(Daily Average)

System	Current ASR	Capability	Rqmt	Difference	Recommended ASR	Change (Tons)
SWA Scenario						
Ground Volcano	2,880 mines	16,161	19,724	-3,563	3,474	+14
Air Volcano	1,728 mines	13,305	9,530	+3,775	1,256	-15
Subtotal						-1
GEMSS	4,216 mines	23,652	31,272	-7,620	5,575	+22
Total Increase						+23
European Scenario						
Ground Volcano	2,880 mines*	15,303	9,600	+5,703	1,930	-23
Air Volcano	1,728 mines'	13,174	7,142	+6,032	974	-24
Subtotal						-47
GEMSS	4,216 mines	22,400	15,680	+6,720	2,952	-21
Total Increase						+26

*Per system per day.

Figure G-9

b. Engineer Class IV and V haul analysis.

(1) In order to estimate the number of truck-hours necessary to fulfill engineer Class IV and V haul requirements, ESC established three planning factors: movement time, round-trip duration, and 5-ton cargo truck haul capacities. These factors and the scenario-generated Class IV and V requirements, made it possible to calculate the truckloads and truck-hours required to transport engineer Class IV and V items.

(a) Movement time. Figure G-10 shows the total time available per day for equipment utilization in each scenario area. (These times

are derived in Annex B.) Of the approximate 11- to 12-hour total in either
scenario area, the portion called productive workday (8 to 9 hours) is dedi-
cated to mission support; i.e., time during which the ACE is digging a tank
ditch or the Ground Volcano is emplacing a minefield module. The remaining
time (3 to 5 hours) is movement time—the time spent moving from job site to
job site. It is also the time available for hauling engineer Class IV and V
items from the BSA forward.

EQUIPMENT WORKDAY
(Hours)

Scenario	Class IV and V Movement		Productive Workday		Total	
SWA	4.95	(44%)	6.30	(56%)	11.25	(100%)
Europe	3.20	(27%)	8.80	(73%)	12.00	(100%)
Weighted Average*	4.36		7.13		11.50	

*Two-thirds SWA; one-third Europe.

Figure G-10

     (b) Round-trip duration. Figure G-11 shows the round-trip
duration for each scenario, derived by using standard time-distance relation-
ships and the parameters of distance, speed, and delays in route. The dis-
tance traveled was from the BSA forward to the engineer company, which ESC
assumed was about 5 km from the FEBA. The speed depended on the percentage of
road and cross-country travel along the route. With the 9ID(MTZ)'s PLS, ESC
assumed only 30 minutes of delay at each end for loading and unloading. The
size of the brigade AOs is apparent from the length of the round-trip duration
in SWA—almost 3 hours. The duration is slightly longer than 2 hours in
Europe.

TRUCK CAPABILITY

	SWA	Europe
Average Distance Traveled (km) (BSA Forward to Engineer Co)	31	18
Average Speed (KMPH)	32	36
Delays (hr)	1	1
Round Trip Duration (hr)	2.92	2.02

Figure G-11

(c) Haul capacity (5-ton cargo truck). The logistic characteristics of FASCAM mines and key engineer munitions are listed in Figure G-12. Each mine or munition type is stacked in its palletized shipping configuration. ESC estimated the truck capacity by determining the number of pallets that would physically fit in a 5-ton cargo truck bed of 88.4 x 168 x 57.4 inches.[1] The truckload then was translated into the total number of mines, MICLICs, M-180s, or MOPMS that could be hauled in a palletized load. For example, based on volume, six pallets of Volcano mines fit on a 5-ton truck, a total load of 1,440 mines.

(2) Using the daily requirements for Class V items generated by each scenario, the data shown in Figures G-10 through G-12, and Equations G-1 and G-2, ESC calculated the truckloads and truck-hours associated with each Class V item (see Figures G-13 and G-14). (Equations 1 and 2 can be used to quantify truck-hours as haul requirement. However, this analysis only considered the truck-hours associated with engineer items.)

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[1]DA, TB 55-46-1.

LOGISTIC CHARACTERISTICS OF FASCAM MINES
AND ENGINEER MUNITIONS

| Type | Single Pallet | | | 5-Ton Cargo Truck Capacity |
	Quantity	Weight (Tons)	Dimensions (Inches)	
RAAM[a]	72 mines	0.437	14.6 x 29.1 x 40.9	1,584 mines[b]
ADAM[a]	288 mines	0.437	14.6 x 29.1 x 39.4	6,336 mines[b]
Volcano[c]	240 mines	0.95	54 x 30 x 35	1,440 mines
MICLIC[c]	1 each	1.55	93 x 53 x 12	2 each
MOPMS[a]	6 boxes	0.535	34 x 53 x 47	36 boxes
M-180[d]	3 kits	0.25	45.5 x 39.8 x 20.5	36 kits

[a]DA, USACE, ESC, An Assessment of the Family of Scatterable Mines (FASCAM) Program (U).
[b]Based on weight; all others on volume.
[c]USAES, Directorate of Combat Developments, Material Division.
[d]DA, TM 9-1375-213-12-1, Operator's and Organizational.

Figure G-12

[Eq G-1]

Class V Requirement/Truck Capacity (Figure G-12) = Truckloads Per Day

[Eq G-2]

Truckloads Per Day x Round-Trip Duration (Figure G-11) = Truck-Hours Per Day

(3) Figure G-15 shows the average daily requirements for engineer Class IV items (tactical wire used in tank ditches and as anti-vehicular obstacles) and the corresponding truckloads and truck-hours by scenario. A 5-ton cargo truck can haul 32 rolls of barbed tape concertina in palletized loads before reaching its volume limit.[2] Ample space remains on the cargo

[2]United States Army Engineer Center and Fort Belvoir, DIO, Transportation Division.

SWA CLASS V REQUIREMENTS
(Daily Average)

System	Requirement	Truckloads	Truck-Hours
RAAM	19,438 mines	13	38
ADAM	3,403 mines	1	3
Air Volcano	9,530 mines	7	20
Non-engineer items		21	61
Ground Volcano	19,724 mines	14	41
MICLIC	32 each	16	47
MOPMS	359 boxes	10	29
M-180	447 kits	13	38
Engineer items		53	155

Figure G-13

EUROPEAN CLASS V REQUIREMENTS
(Daily Average)

System	Requirement	Truckloads	Truck-Hours
RAAM	15,699 mines	10	20
ADAM	3,224 mines	1	2
Air Volcano	7,142 mines	5	10
Non-engineer items		16	32
Ground Volcano	9,600 mines	7	14
MICLIC	60 each	30	61
MOPMS	346 boxes	10	20
M-180	1,009 kits	29	58
Engineer items		76	153

Figure G-14

truck to haul the modest amounts of pickets and reels of barbed tape asso-
ciated with the concertina. The Class IV requirement for SWA is 70 truck-
hours; Europe is 52.

CLASS IV ENGINEER REQUIREMENTS
(Daily Average)

| | | Requirements | | | |
| | | Barbed Tape Concertina | Barbed Tape | | |
	Meters	(Rolls)	(Reels)	Truckloads*	Truck-Hours
		SWA Scenario			
Tank Ditch	6,141	404	16	13	38
Other Wire	392	352	14	11	32
Total		756	30	24	70
		European Scenario			
Tank Ditch	2,911	192	8	6	12
Other Wire	1,456	640	24	20	40
Total		832	32	26	52

*USAEC, DIO, Transportation Division.

Figure G-15

(4) Figure G-16 lists the total engineer Class IV and V require-
ments, the divisional engineer battalion's haul capability, the resulting
shortfall, and the number of 5-ton cargo truck required to overcome the
shortfall.

(a) The Class IV and V requirements are summarized from the
data already given in Figures G-13, G-14, and G-15.

(b) The divisional engineer battalion's haul capability is
based on their 26 organic 5-ton trucks that are prime movers for the LAB,
MICLIC, and Ground Volcano, and from the data listed in Figure G-10. The
dedicated mission time is removed from the total time available (in

truck-hours), leaving only 128 and 83 truck-hours of capability, respectively, for the SWA and European scenarios (Class IV and V movement time).

CLASS IV AND V HAUL ANALYSIS
(Truck-Hours)

	SWA	Europe	Weighted Average*
Haul Requirements			
Class V	155	153	155
Class IV	70	52	64
Total	225	205	219
Divisional Engineer Capability			
Class IV and V Movement	128	83	114
Productive Workday	164	229	185
Total	292	312	299
Battalion Shortfall	97	122	105
Trucks	(20)	(38)	(25)

*Two-thirds SWA; one-third Europe.

Figure G-16

(c) A battalion shortfall of plus or minus 100 truck-hours exists in both scenarios when the haul requirements are compared to the engineer battalion's Class IV and V movement time capability.

(d) The shortfall in available truck-hours can be compensated by adding 20 and 38 five-ton trucks to the engineer battalion, respectively, in the SWA and European theaters. Figure G-10 shows that each additional truck provides only 44 and 27 percent of its total daily available time toward Class IV and V movement in the SWA and European scenarios, respectively. The majority of its available time is dedicated to mission support, an area of even greater 5-ton truck shortfall than Class IV and V haul.

c. Distribution of 5-ton cargo trucks within the divisional engineer battalion.

(1) Thirty-two 5-ton cargo trucks are now in the engineer battalion, six of which are in the company maintenance section and haul either tank and pump units or PLL repair parts and automotive tool sets. The remaining 26 trucks are associated with either the Volcano (6), LAB (10), or MICLIC (10) systems. It is these latter 26 trucks that can be used to haul engineer Class IV and V items when they are not engaged in dedicated mission work.

(2) Figure G-17 lists, by scenario, the daily emplacement capability, the average and peak requirements, and the required number of systems necessary, on an average and peak basis, to meet the requirements for Ground Volcano minefields, LAB spans, and MICLIC breaches.

(a) ESC determined each system's capability by dividing the productive workday time (see Figure G-10) for each scenario area by the time it takes that system to complete one mission.

(b) The scenario, in concert with the countermobility and mobility methodologies, generated the average daily and peak requirements for minefields, small-gap spans, and minefield breaches.

(c) By dividing the average and peak requirements by the capability of one system, ESC estimated the number of systems needed to meet the requirements.

(d) Figure G-17 also shows that in both scenarios, only six systems (and therefore six trucks) are required to satisfy the average daily requirements, while peak requirements need 17 and 19 systems and trucks in SWA and Europe, respectively, to meet the demand.

(3) Weighting the SWA scenario twice as much as the European scenario, ESC calculated the weighted average for system requirements for each

G-17

of the three systems. Figure G-18 shows the weighted average for system requirements and also lists ESC's recommendation on the redistribution of the twenty-six 5-ton cargo trucks within the engineer battalion.

MOBILITY AND COUNTERMOBILITY SYSTEM REQUIREMENTS

| | | Requirements | | | |
| | | Scenario Total | | Unit System | |
System	Capability*	Avg	Peak	Avg	Peak
	SWA Scenario				
Ground Volcano (6)	9.3 minefields	21	70	3	8
LAB (10)	15 spans	0	0	0	0
MICLIC (10)	11 breaches	32	98	3	9
Total				6	17
	European Scenario				
Ground Volcano (6)	13 minefields	10	19	1	2
LAB (10)	15 spans	14	30	1	10
MICLIC (10)	15 breaches	60	94	4	7
Total				6	19

*Per individual system per day.

Figure G-17

ENGINEER 5-TON CARGO TRUCKS

| | | Weighted System Requirements | | |
Mission	Design TOE	Avg	Peak	Recommendation
Ground Volcano	6	2	6	8
MICLIC	10	3	8	8
LAB	10	1	3	4
Undedicated	--	--	--	6
Total	26	6	17	26

*Two-thirds SWA; one-third Europe.

Figure G-18

(a) To meet the peak usage requirements for the Ground Volcano and provide equal capability in each engineer company, ESC recommends the number of Ground Volcanos be increased from the present six to eight, allowing two per company.

(b) The MICLIC peak requirements are less than the current allocation. Thus, ESC recommends reducing the battalion's MICLICs from 10 to eight, again allowing two per engineer company.

(c) The requirements for LABs are very terrain dependent, and moving the division's AOs to different locations within SWA would dramatically increase the LAB requirements. These relocations would move the division from open terrain and a large AO to less optimum areas where the division loses its force mobility and has consequently less combat effectiveness. Based on the terrain of the given scenario areas, the LAB requirement peak of three, and the published divisional operational concept, ESC recommended the distribution of one LAB per company, thus decreasing the current battalion total of 10 to four.

(d) Six trucks remain without a dedicated mission. These vehicles should be used to overcome the shortfall in truck-hours, both in the mission support area and the Class IV and V haul area.

d. C-141B sortie payoff.

(1) The 9ID(MTZ)'s scatterable mine operations are now supported by three branches of the Army--artillery, aviation, and engineers. These three systems differ in their responsiveness, vulnerability, and efficiency with respect to the installation of minefields on the battlefield. One system may be more appropriate for a particular mine mission than another system, depending on time available and location of the obstacle on the battlefield.

G-19

For example, artillery is favored on missions to interdict second echelon forces, while engineer or aviation minefields would be more appropriate behind friendly lines. One system alone can not execute all the missions that could arise on the battlefield; a combination of two different systems could support most of the missions, but rather inefficiently. The three systems together account for 60 to 90 percent of all obstacles, depending on the scenario. Since the ideal situation of all three systems working in concert for the division commander may be politically or logistically impractical, the pay-off in terms of C-141B sorties and minefields for each system would be an appropriate decision-making tool.

(2) ESC addressed this issue from two perspectives:

(a) The first approach examined the emplacement of the equivalent of 30 artillery minefields by all three branches in terms of C-141B sorties necessary to airlift a single system, and all the required Class V requirements to execute the minefields. Ground Volcano modules equate 1:1 with artillery modules, while Air Volcano modules are 1.67:1.[3] Figure G-19 lists the results of that analysis. Based on the number of sorties, either Ground or Air Volcano is the least costly system to emplace the equivalent of 30 artillery minefields, using three dedicated sorties and a portion of a fourth.

(b) The second approach evaluated a single C-141B sortie for each system and determined the number of minefields that one sortie could deliver to a theater. Each C-141B carried one mine dispensing system and its prime mover; the remainder of load was composed of Class V pallets. A variant

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[3]The relative size of the different minefield modules is addressed in Annex D.

of this approach looked at Class V only, assuming that no additional systems must be transported to the theater. Figure G-20 shows the results both of the basic approach and the variation. The best pay-off in a mixed load is Air Volcano, with one sortie having the potential of 7.5 minefields. The pure Class V sortie favors both Volcano systems, which is logical since both use identical mines and mine dispensers.

SYSTEM AFFORDABILITY*

System	Class V 463L Pallets	C-141B Sorties**
Artillery (155-mm Tube & 5-Ton Truck)	32	5.14
Ground Volcano (Dispenser & 5-Ton Truck)	24	3.7
Air Volcano (Dispenser & Helicopter)	24	3.6

*Based on emplacing the equivalent of 30 artillery minefield modules.
**To airlift one system and associated Class V requirements.

Figure G-19

(3) If the division were to lose some or all of its artillery-delivered mine capability, then this analysis would indicate that some of the shortfall could be best overcome by adding Air Volcano systems. But the absence of any one system would leave a gap in the division's obstacle plan, since each system accounts for 25 to 39 percent of the total minefield plan. That gap can be reduced, but not eliminated. The systems are complimentary, but by no means redundant. Having one does not preclude the need for the other two. The question then becomes one of risk—how much risk is the commander willing to accept, knowing that his scatterable mining capability is degraded while his concept of operation mandates a dynamic use of minefields?

G-21

SINGLE C-141B SORTIE PAYOFF

System	Equipment	Cargo					
		Mixed Load			Pure Class V Load		
		Add'l Ammo*	M/F Equiv	Pay-Off	Ammo*	M/F Equiv	Pay-Off
Artillery	M-198 Howitzer 5-Ton Truck	3	2.5	1.0	7	5.78	1.0
Air Volcano	UH-60A Helicopter	6	7.5	3.0	7	8.75	1.5
Ground Volcano	5-Ton Truck	5	6.3	2.5	7	8.75	1.5

*Number of 463L pallets.

Figure G-20

LAST PAGE OF ANNEX G

ANNEX H

ENGINEER EAD FORCE STRUCTURE

ANNEX H

ENGINEER EAD FORCE STRUCTURE

1. <u>Purpose</u>. This annex describes the methodology used to determine the EAD (corps) engineer units required to support the 9ID(MTZ).

2. <u>Scope</u>. This annex:

a. Identifies which EAD units and EAD unit missions are best suited to support the motorized division.

b. Determines the number and type of EAD units needed for each theater.

c. Designs EAD equipment levels, for the selected EAD units, based on weighted scenarios requirements and unit package alternatives.

3. <u>Methodology</u>. Figure H-1 shows the general methodology ESC used to determine the engineer EAD force structure. This methodology calculates the engineer requirements excess to the division's own capability, then looks at the existing and proposed corps engineer units that could satisfy these excess requirements (excluding bridging).

ENGINEER EAD METHODOLOGY
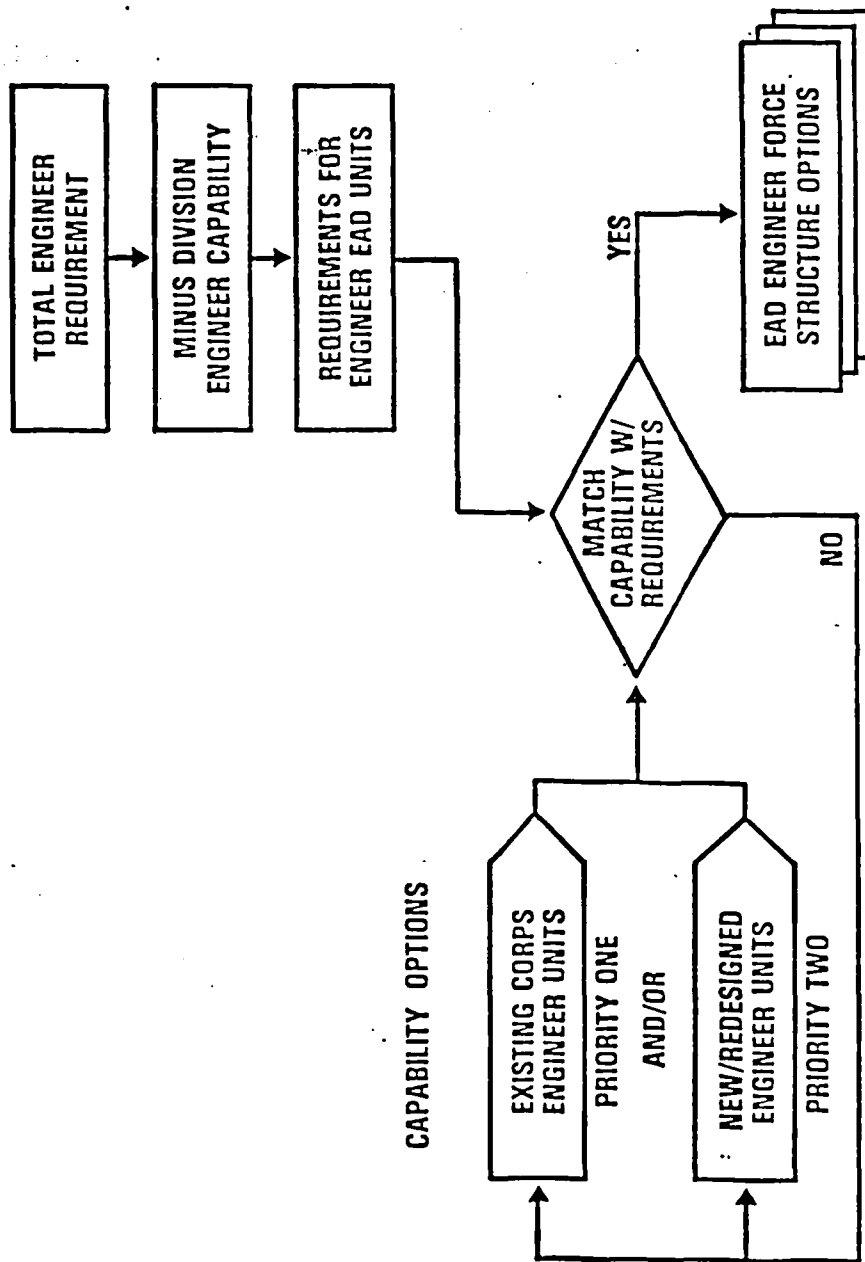
Figure H-1

a. Step 1: match capability to requirements.

(1) The primary step of the EAD methodology matched the capability of different combinations of corps engineer units to the 9ID(MTZ)'s engineer support requirements. A match is possible when 100 percent of the unexecuted requirements are satisfied and little excess capability remains in any area. The matching process first attempted to use existing units as listed in Figure H-2.

EXISTING ENGINEER EAD UNITS

TOE	Description
5-35H	Engineer Combat Battalion, Corps
5-45H	Engineer Combat Battalion (Mechanized), Corps
5-115H	Engineer Combat Battalion, Heavy
5-195H	Engineer Combat Battalion, Airborne
5-54H	Engineer Light Equipment Company, Airborne
5-58H	Engineer Combat Support Equipment Company
5-114H	Engineer Construction Support Company
5-124H	Engineer Dump Truck Company
5-129H	Engineer Port Construction Company
5-177H	Engineer Pipeline Construction Support Company

Figure H-2

(2) When the capability of existing corps engineer units did not satisfy the unexecuted requirement, ESC tried to match the requirement to the capability anticipated in a new, proposed unit.

(3) The proposed units considered were often simply existing units, where key components were increased or decreased to form a new composition. (Altering existing units by increasing or decreasing components is the preferred method of creating new units.) If components are decreased, partial unit deployments were considered.

(4) The corps engineer battalions and combat support equipment company were the prime unit candidates for component redistribution. However,

the analysis also considered that a new unit could be required. Figure H-3 lists the proposed units that were candidates for EAD support of the 9ID(MTZ).

PROPOSED ENGINEER EAD UNITS

TOE	Description	Study[a]	Agency
5-38H	Combat Support Equipment Company		
5-35H	Corps Battalion (Wheel)	III, V, and VII Corps Studies[b]	ESC
5-54J	Light Equipment Company		
5-195J	Corps Battalion (Airborne)	FC 100-1[c]	USAES
5-35J	Corps Battalion (Wheel)		

[a]Each study lists major unit components; the J-series TOEs referenced currently exist in unit reference sheet format.
[b]DA, USACE, ESC, Analysis of III Corps Combat Engineer Wartime Requirements (U); Analysis of V Corps Combat Engineer Wartime Requirements (U); Analysis of VII Corps Combat Engineer Wartime Requirements (U).
[c]DA, TRADOC, CACDA, FC 100-1, The Army of Excellence.

Figure H-3

b. Step 2: determine the influence of scenario dynamics and time. The matching process was both scenario- and time-sensitive.

(1) Scenario sensitivity results in different deployment troop lists per theater.

(2) Time sensitivity is the condition when requirements vary greatly by time period within a scenario. To determine how time-sensitive requirements affect capability, requirements were reviewed in priority order (vital only, vital and critical only, etc.). In this fashion, important requirements were satisfied and capability was normalized over the time line. (Deferring requirements to a future time period was not considered practical, since the battle phases of the SWA and European scenarios last only 2 or 3 days.)

c. Step 3: investigate the effects of the study excursions. Annexes A and I describe the five study excursions ESC developed for use in each scenario. Figure H-4 shows how these excursions—notably Excursion A—were used to round out the analysis described in this annex.

STUDY EXCURSIONS

Excursion Title	Purpose	Scenario	
		SWA	Europe
A. Corps Battalion	Capability impact of two engineer battalions (divisional & one corps) on Divisional Case I requirements	Yes	Yes
B. Brigade Effort	Impact of allocating divisional engineer battalion solely to brigade sector (Case II) requirements	Yes	Yes
C. DRA Effort	Impact of allocating corps engineer units solely to DRA (Case II) requirements	Yes	Yes
D. Priority Work	Impact of Case II capability versus vital and critical priority group requirements	36-hour MBA delay*	48-hour CFA/MBA delay*
E. Direct-Fire Emplacements	Impact of digging in DRAGON and vehicular AT weapon emplacements	Yes	Yes

*These delay periods were key situations and were used to determine the engineer EAD force structure and divisional engineer battalion structure.

Figure H-4

d. Step 4: recommend an EAD force structure. ESC evaluated alternative EAD force structures and recommended them in priority sequence. The main study determined what missions were most appropriate for the division engineer battalion, and which were appropriate for corps engineer units. Those results were used to structure the process ESC followed to rank alternate EAD unit structures. However, additional subjective analysis also was

required in liaison with the SAG, the US Army Engineer School, and the rest of the engineer community.

4. <u>EAD Unit Engineer Capability</u>. ESC determined that four engineer units, in various allocation mixes, could satisfy the existing Case II (augmentation) requirements for both scenarios: a light equipment company (airborne); a combat battalion (airborne); a combat support equipment company; and a combat battalion (corps).

a. Figure H-5 shows the aircraft sorties necessary to deploy each of these four units, plus the 9ID(MTZ)'s engineer battalion. Both DA and DOD loading systems were shown for comparison.

AIRCRAFT SORTIES FOR DEPLOYING ENGINEER UNITS

Engineer Unit	AALPS[a]		J4 – JCS[b]		Profile[c]	
	C-141 + C-5A		C-141 + C-5A		AALPS	J4
Light Equipment Company, Airborne	33	1	46	1	1.0	1.0
Combat Battalion, Airborne	55	1	76	1	1.8	1.8
Combat Support Equipment Company	30	18	29	30	0.5	0.6
Combat Battalion, Corps	74	2	102	7	1.6	1.7
Engineer Battalion, Infantry Division (Motorized)	55	--	--	--	2.4	--

[a]Number of sorties based on Automated Airlift Load Planning System (AALPS).
[b]Number of sorties based on TPFDD.
[c]Profile numbers indicate Relative Degree of Transportation Responsiveness.

Figure H-5

(1) DA's Automated Aircraft Load Planning System (AALPS) calculates loading for C-141B aircraft based on bulky equipment. Using AALPS,

smaller equipment is loaded in, on, and around the bulky equipment. ADEA has validated AALPS for the 9ID(MTZ) during actual exercises.

(2) The DOD system is used for deployment planning and calculates loading based on loading of all TOE equipment separately, both bulky and small. ESC created a transport profile that rates the unit's size and responsiveness for air transport.

(3) Figure H-5 shows that, for any given unit, either system provides approximately the same profile. ESC used the AALPS profile for the remainder of this analysis.

b. Figure H-6 compares transport profile to capability for each of the five units. Capability is expressed in average hours per day of the MBA fight for each scenario. The equipment mix of the three key or dominant items of equipment--bulldozer, SEE, and 5-ton truck--are also shown. Figure H-6 was used to build each scenario's force structure. That process emphasized using light units (high-profile number) for vital tasks and heavy units (low-profile numbers) for the lower priority critical tasks.

5. <u>SWA Engineer EAD Unit Force Structure</u>. The SWA EAD force was designed to satisfy the initial 36-hour MBA delay for vital and critical requirements. The main report discusses the reasons for selecting this key situation.

a. Figure H-7 shows the engineer requirements satisfied during the initial 36-hour MBA fight (Periods 3 and 4). During this key situation, only a portion of vital work is done; no critical (or lower priority group) work is possible.

b. Figure H-8 shows the engineer shortfall for the key situation and the engineer units required to alleviate each portion of that shortfall. The

ENGINEER UNIT CAPABILITY

	Capability[a]		Equipment Mix[b]			
	Squad-Hours[c]	Equipment Hours	D7/ACE (%)	JD410 SEE (%)	5-Ton Trucks (%)	Transport Profile[d]
Light Equipment Company, Airborne			1	3	1	1.0
SWA	0	270	--		--	--
Europe	0	391	--		--	--
Combat Battalion, Airborne			6	5	40	1.8
SWA	147	324	--		--	--
Europe	200	470	--		--	--
Combat Support Equipment Company			7	3	69	0.5
SWA	0	599	--		--	--
Europe	0	872	--		--	--
Combat Battalion, Corps			26	33	26	1.6
SWA	311	318	--		--	--
Europe	425	462	--		--	--
Engineer Battalion, 9ID (MTZ)			35	46	19[e]	2.4
SWA	138	233	--		--	--
Europe	189	332	--		--	--

[a]Average hours per day for MBA fight.
[b]Percentages are given for two of five most dominantly used items of equipment.
[c]Seven-man squad.
[d]Low number = difficult transport; high number = easy transport.
[e]Assumes ten 5-ton trucks are available, usually dedicated to LAB or MICLIC.

Figure H-6

top half of Figure H-8 shows the shortfall and the impact of deploying only a few units; the bottom half shows the units required (forward to rear) to accomplish all vital and critical tasks. Figure H-8 shows that:

SWA SCENARIO--KEY SITUATION SHORTFALLS

Case or Excursion	Key Periods	Vital Requirements Completed (%)	
		Squad	Equipment
Case I	3	30	27
(Base)	4	29	31
Case II	3	85	49
(Augmentation)	4	85	61
Excursion A	3	90	60
(Two engineer battalions)*	4	85	67

*Case I requirements with Case II capability.

Figure H-7

(1) No single EAD engineer battalion combined with the division engineer battalion can complete all tasks in the vital priority group in the brigade forward tasks.

(2) At least one corps battalion must be used to support the divisional engineer battalion in the brigade areas.

(3) An airborne package (a battalion with a light equipment company) is added to the minimum EAD support (two engineer battalions) to complete all vital tasks, front to rear.

(4) Besides the units required to complete vital tasks, four additional corps battalions and two CSE companies are needed to complete all critical tasks in the division AO.

Number of Engineer Units						Requirement Shortfall*			
Div Bn	Corps Bn	CSE Co	Abn Bn	Lt Equip Co	Type Effort	Vital		Critical	
						Bde	DRA	Bde	DRA
--	--	--	--	--	Squad	722	41	236	1,483
--	--	--	--	--	Equip	1,015	444	758	3,057
1	--	--	--	--	Squad	501	41	236	1,483
1	--	--	--	--	Equip	642	444	758	3,057
1	1	--	--	--	Squad	72	41	236	1,483
1	1	--	--	--	Equip	192	444	758	3,057
1	--	--	1	--	Squad	281	41	236	1,483
1	--	--	1	--	Equip	156	444	758	3,057
1	1	--	1	--	Squad	0	0	129	1,483
1	1	--	1	--	Equip	0	150	758	3,057
1	1	--	1	1	Squad	0	0	129	1,483
1	1	--	1	1	Equip	0	0	503	3,057
1	2	--	1	1	Squad	0	0	0	1,145
1	2	--	1	1	Equip	0	0	26**	3,057
1	5	2	1	1	Squad	0	0	0	0
1	5	2	1	1	Equip	0	0	0	148**

*36-hour MBA fight only; listed in seven-man squad-hours and dominant equipment-hours.

**Not considered significant; requirements essentially completed.

Figure H-8

6. European Engineer EAD Unit Force Structure. The Europe EAD force was designed to meet the 48-hour delay for vital and critical requirements. Highlights of this key situation are described below.

a. Figure H-9 shows the vital and critical requirements completed during the key situation (Periods 2, 3, and 4). The lodgement phase (Period 1) that proceeded this key situation had excess engineer capability. This excess could not be applied to the combat phase, since the division had

not received its mission yet. Like the SWA scenario, the key situation is improved when two engineer battalions are available (Case II and Excursion A). The key situation differs by priority group:

EUROPEAN SCENARIO--KEY SITUATION SHORTFALLS

Case or Excursion	Key Periods	Requirements Completed(%)			
		Vital Priority		Critical Priority	
		Squad	Equipment	Squad	Equipment
Case I	2	44	29	--	--
(Base)	3	100	100	100	31
	4	56	43	--	--
Case II	2	89	47	--	--
(Augmentation)	3	100	100	100	100
	4	100	99	8	0
Excursion A	2	89	47	--	--
(2 Engineer Battalions)*	3	100	100	100	100
	4	100	100	7	--

*Case I requirements with Case II capability.

Figure H-9

(1) In the vital priority group, the shortfall is most apparent during the 12-hour CFA operation (Period 2). During this operation, engineers can execute only about 50 percent of the equipment-hour tasks.

(2) For the critical priority group, capability is only available during Period 3, which is the first 24 hours of the MBA fight. Requirements are lower during Period 3 because the FEBA movement is slow and the brigade and division rear boundaries remain intact.

(3) Figure H-9 does not show the requirements completed during Period 3 in the last two priority groups. If this capability could be diverted to Period 4, vital work, it would improve the division's performance by raising Period 4's vital accomplishments to about 40 percent for squad tasks and 30 percent for equipment tasks.

H-12

b. Figure H-10 shows the engineer shortfall for the European scenario and the engineer EAD force structure needed to remedy this shortfall. Notice that there are no vital DRA tasks, and only a small number of squad- and equipment-hours needed for critical brigade tasks. The bulk of the workload is split between vital brigade tasks (20 percent) and critical DRA tasks (80 percent). This situation is vastly different from the SWA scenario. This result suggests a need for a very different EAD force structure.

EUROPEAN ENGINEER EAD UNIT CAPABILITY COMPARISON

Number of Engineer Units						Requirement Shortfall*			
						Vital		Critical	
Div Bn	Corps Bn	CSE Co	Abn Bn	Lt Equip Co	Type Effort	Bde	DRA	Bde	DRA
--	--	--	--	--	Squad	690	0	25	2,758
--	--	--	--	--	Equip	1,797	0	207	5,644
1	--	--	--	--	Squad	207	0	25	2,758
1	--	--	--	--	Equip	950	0	207	5,644
1	1	--	--	--	Squad	0	0	0	2,214
1	1	--	--	--	Equip	102**	0	207	5,644
1	--	--	1	--	Squad	0	0	0	2,590
1	--	--	1	--	Equip	10**	0	207	5,644
1	1	1	--	--	Squad	0	0	0	2,214
1	1	1	--	--	Equip	0	0	0	4,209
1	4	2	--	--	Squad	0	0	0	0
1	4	2	--	--	Equip	0	0	0	0

*48-hour CFA/MBA delay; listed in seven-man squad-hours and dominant equipment-hours.
**Not considered significant; requirements essentially completed.

Figure H-10

(1) One single EAD engineer battalion combined with the divisional engineer battalion can complete all vital brigade forward tasks.

(2) No airborne engineer unit is required in Europe to support the motorized division. As a test, Figure H-10 substitutes an airborne engineer battalion for a corps engineer battalion. The airborne battalion

H-13

improved execution of equipment-hour vital tasks, but the corps battalion exceeded the airborne unit in squad-hour execution. This can be observed in the DRA critical task column and is explained by the fact that the corps battalion has double the squad power of the airborne unit.

(3) At least one corps battalion must be used to support the divisional engineer battalion in the brigade areas.

(4) Besides the units required to complete vital tasks, three corps battalions and two CSE companies are needed to complete all critical tasks in the division AO.

7. Excursion A: Two Engineer Battalions. This excursion tested the impact of committing the divisional and one corps engineer battalion to only the division's requirements.

a. For purposes of this analysis, it was assumed that division-only requirements (Case I) were to be worked on by both divisional and EAD engineer capabilities (Case II). The excursion can also be described as the 9ID(MTZ) division deploying with only one EAD unit--the corps engineer battalion.

b. Figures H-11 and H-12 show the squad-hour results for each scenario in this excursion. Figures H-13 through H-15 show the excursion results in equipment-hours. Figure H-14 provides a closer examination of some of the data presented in Figure H-13. Figure H-16 summarizes the results for the key periods which occur during the MBA delay.

c. As expected, more requirements are met during Excursion A than during either Case I or Case II. However, the increase in accomplished squad-hours is more noticeable. ESC observed from this excursion that:

H-14

SWA DIVISION AND EAD CAPABILITY AND DIVISIONAL REQUIREMENTS
FOR ALL SCENARIO PERIODS
Excursion A--Two Engineer Battalions
(Squad-Hours)

SWA 60-HR DELAY
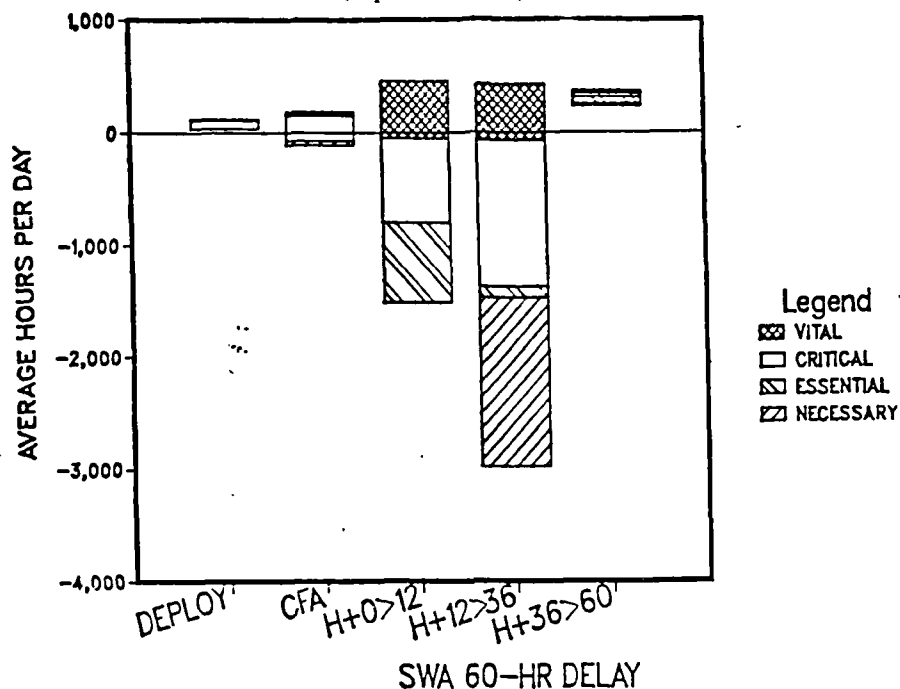
Figure H-11

EUROPEAN DIVISION AND EAD CAPABILITY AND DIVISIONAL REQUIREMENTS
Excursion A--Two Engineer Battalions
(Squad-Hours)

EUROPE 48-HR DELAY
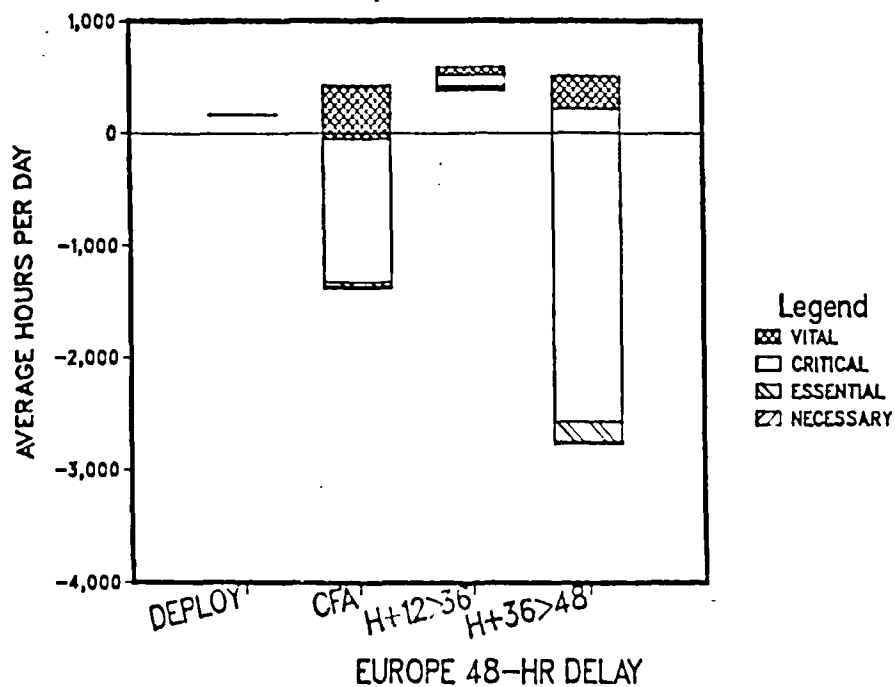
Figure H-12

SWA DIVISION AND EAD CAPABILITY AND DIVISIONAL REQUIREMENTS
FOR ALL SCENARIO PERIODS
Excursion A--Two Engineer Battalions
(Equipment-Hours)

SWA 60-HR DELAY
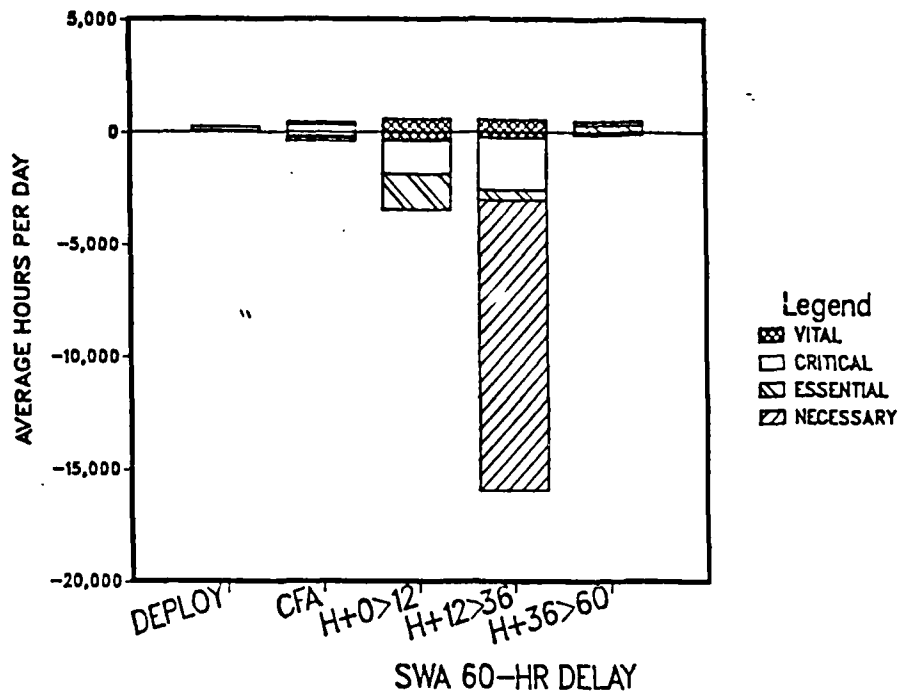
Figure H-13

SWA DIVISION AND EAD CAPABILITY AND DIVISIONAL REQUIREMENTS
FOR SCENARIO PERIODS 1, 2, AND 5
Excursion A--Two Engineer Battalions
(Equipment-Hours)

SWA 60-HR DELAY
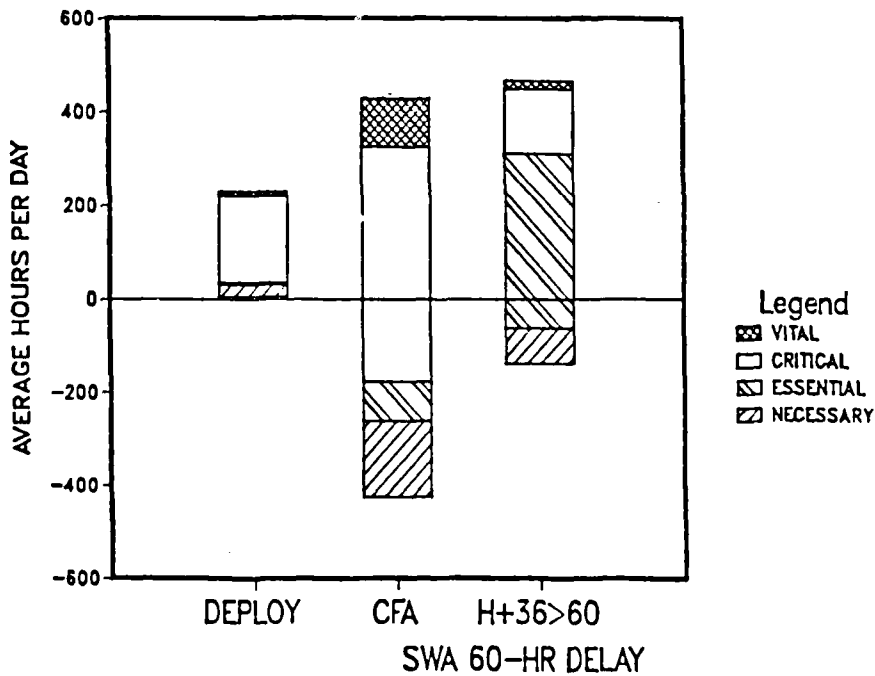
Figure H-14

EUROPEAN DIVISION AND EAD CAPABILITY AND DIVISIONAL REQUIREMENTS
Excursion A--Two Engineer Battalions
(Equipment-Hours)
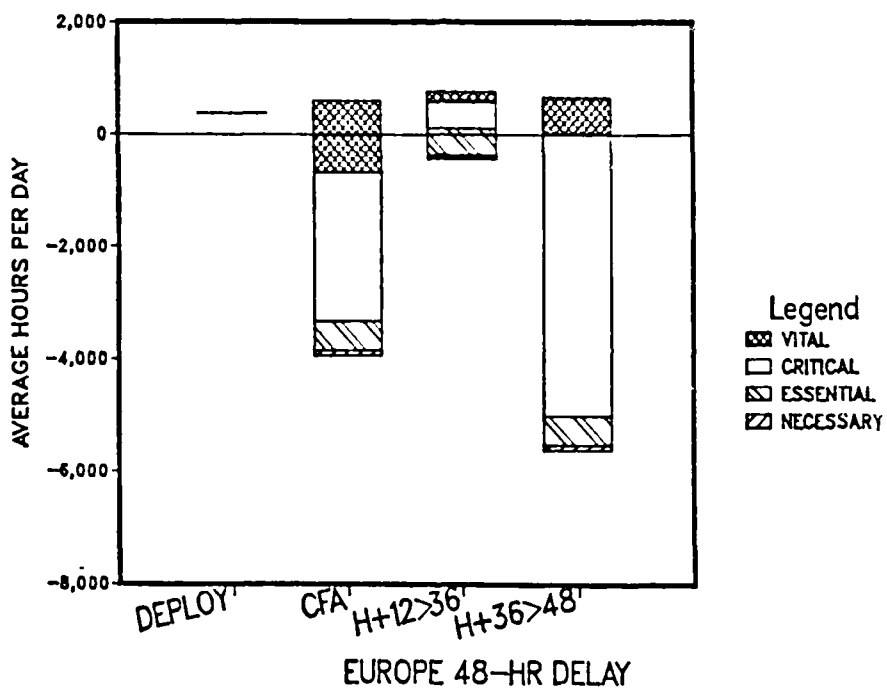
Figure H-15

COMPARISON OF COMPLETED REQUIREMENTS
(Excursion A)

Case or Excursion	Type Effort	Vital Scenario Requirements Completed (Percentages)*	
		SWA	Europe
Case I (Base)	Squad	29	69
	Equipment	30	60
Case II (Augmentation)	Squad	85	96
	Equipment	57	79
Excursion A	Squad	87	96
	Equipment	65	79

*Key situation of each scenario.

Figure H-16

(1) A dramatically higher number of vital requirements were met during either scenario when a second engineer battalion was brought in to help the divisional engineer battalion.

(2) As long as the majority of requirements are generated by the division (vis-a-vis EAD units), the impact of Excursion A compared to Case II is minor while the impact of Excursion A to Case I is major.

(3) With the addition of a corps engineer battalion, the improvement in equipment task accomplishment is less than the improvement in squad task accomplishment. (This observation shows the importance of equipment distribution in this unit.)

8. Engineer EAD Unit Design.

a. ESC redesigned engineer EAD units based on accepting certain risks:

(1) Annex I shows that direct-fire weapon emplacements are time-intensive to prepare and predominant during defensive operations. Since these

H-18

emplacements also require the equivalent of an engineer battalion to complete, this workload was assigned to the equipment intensive CSE and light equipment EAD companies.

(2) Vital tasks in the brigade area became a shared responsibility between the divisional battalion and one corps engineer battalion. The division battalion structure, however, must be capable of supporting counterattacks without any help from the corps battalion, or any other EAD unit (Annex I).

(3) DRA vital tasks were assigned to a airborne engineer battalion and a light equipment company. Since there are no DRA vital tasks in Europe, the two units were only structured for SWA.

(4) The corps engineer battalion was structured to complete all critical, necessary, and essential tasks, plus tasks in the CRA. This seemingly impossible versatility is possible if one CSE company is included in the EAD structure for every two corps battalions.

(5) Changes in the equipment mix of EAD units were based on changes previously recommended by ESC for III, V and VII Corps units in Europe.[1] It was determined that equipment requirements for the DRA, especially for essential and necessary tasks (about 50 to 75 percent of all tasks), were similar for all divisions and theaters.

(6) Figure H-17 summarizes the EAD design parameters recommended by this analysis.

b. The airborne engineer battalion and the light equipment company were redesigned based on the requirement mix found in the SWA scenario.

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[1]DA, USACE, ESC, Analysis of III Corps Combat Engineer Wartime Requirements, Analysis of V Corps Combat Engineer Wartime Requirements, and Analysis of VII Corps Combat Engineer Wartime Requirements.

Figure H-18 shows this mix and averages the existing capability of these two units.

MISSION ORIENTATION FOR EAD ENGINEER UNITS

Unit	Counterattack	Brigade (-)[a]	DRA	CRA
Divisional Battalion	All Tasks --	50% brigade vital tasks	--	NA
Corps Battalion (Wheeled)	--	50% Brigade Vital Tasks 100% Critical Tasks	Essential & Necessary Tasks	All Tasks
Airborne Battalion	--	100% Vital DRA Tasks	--	NA
CSE Company	--	Direct-Fire Weapon Emplacements[b]	Essential & Necessary Tasks	All Tasks
Light Equipment Company	--	Direct-Fire Weapon Emplacements[c]	--	--

[a]Assumes vital tasks do not include direct-fire weapon emplacement tasks.
[b]Developed theater.
[c]Undeveloped theater.

Figure H-17

(1) Based on the differences between the desired requirement mix and actual capabilities (Figure H-18), the units were redesigned as shown in Figures H-19 and H-20.

(2) The airborne engineer battalion is adjusted by reducing the number of dump trucks and scrapers in its inventory so the number of bulldozers can be increased (Figure H-19).

(3) The light equipment company also loses dump trucks and scrapers to gain more bulldozers. The dump truck is also standardized for the 5-ton capacity; graders are deleted (battalion graders are sufficient); and 12

SEEs are added. The SEE gives this unit the ability to supplement the divisional engineers with direct-fire emplacement support.

AIRBORNE PACKAGE (BATTALION PLUS COMPANY) EQUIPMENT MIX
(Percentages)

Requirement and Capability	ACE D7	Loader	Grader	5-Ton Truck	SEE JD410
SWA REQUIREMENT CAPABILITY	45	16	10	28	1
Current TOEs					
Airborne battalion	16	16	13	40	5
Light Equipment company	21	11	16	21	--
Average*	19	14	15	31	3
ESC-Recommended					
Airborne battalion	39	16	13	25	7
Light Equipment company	46	9	0	27	18
Average*	43	13	7	26	13

*Equal weight; one company and one battalion deploy together.

Figure H-18

c. The corps engineer battalion and CSE company were redesigned to better support both theaters. Figure H-21 shows the required equipment mix for each, based on weighting the requirements of the SWA scenario 2-to-1 against those of the European scenario. The capability of these units then was compared to this requirement. Figure H-21 shows the capability was also weighted, this time, the battalion at a 2-to-1 mix over the Company.

(1) The weighted capability does not match the weighted requirement mix, so the units were redesigned as shown in Figures H-22 and H-23.

(2) The corps engineer battalion has all its equipment increased (Figure H-22). These increases were made possible by reducing the corps squad to the same size as that found in other combat engineer units. Two-thirds of this reduction was applied to acquiring additional equipment operators.

ENGINEER COMBAT BATTALION (AIRBORNE) DESIGN RECOMMENDATIONS
(Key Equipment Only)

Key Equipment	Current TOE 5-195H		ESC Recommendation	
	Number	Percentage	Number	Percentage
Bulldozer (Sectionalized)	10	16	24	39
Front-End Loader (2.5CY)	10	16	10	16
Grader	8	13	8	13
5-Ton Dump Truck	24	40	15	25
Wheeled Tractor With Scraper (7.5 CY)	6	10	--	--
JD410	3	5	4	7
TOTAL	61	100	61	100

Figure H-19

LIGHT EQUIPMENT COMPANY (AIRBORNE) DESIGN RECOMMENDATIONS
(Key Equipment Only)

Key Equipment	Current TOE 5-195H		ESC Recommendation	
	Number	Percentage	Number	Percentage
Bulldozer (Sectionalized)	12	21	30	45
Front-End Loader (2.5 CY)	6	10	6	9
Grader	9	16	0	0
2-1/2-Ton Dump Truck	18	16*	0	0
5-Ton Dump Truck	12	21	18	27
Wheeled Tractor With Scraper (7.5 CY)	9	16	0	0
SEE	--	--	12	18
TOTAL	66	100	66	100

*Weighted percentage; Two 2-1/2tons = one 5-ton.

Figure H-20

H-22

CORPS BATTALION PLUS CSE COMPANY EQUIPMENT MIX
(Percentages)

Requirement and Capability	ACE D-7	Loader	Grader	5-Ton Truck	SEE JD410
REQUIREMENT					
SWA	45	16	10	28	1
Europe	41	31	1	27	--
Weighted average*	44	21	7	28	--
CAPABILITY					
Current TOEs					
Corps battalion	26	17	8	26	23
Combat support equipment company	7	7	7	69	3
Weighted average**	20	14	8	40	16
ESC Recommended					
Corps battalion	44	12	10	29	5
Combat support equipment company	41	15	--	24	20
Weighted average**	43	13	7	27	10

*SWA = double weight, Europe = single weight.
**Two corps battalions plus one combat support equipment company.

Figure H-21

(a) The largest increase was for bulldozers, followed by graders, then dump trucks.

(b) The SEEs were reduced from 12 to 4, and the excess applied against the CSE company.

(3) The changes made to the CSE company (Figure H-23) were similar to those made to the light equipment company.

(a) Bulldozers, loaders, and SEEs were increased. The SEEs and bulldozers give the unit a direct-fire weapon emplacement capability.

(b) The scrapers and 20-ton dump trucks were deleted; graders were deleted and transferred to the corps Battalion. Five-ton dump

WHEELED CORPS ENGINEER BATTALION DESIGN RECOMMENDATIONS
(Key Equipment Only)

Key Equipment	Current TOE 5-35H		ESC Recommendations*	
	Number	Percentage	Number	Percentage
Bulldozer	14	26	34	44
Front-End Loader (2.5 CY)	9	17	9	12
Grader	4	8	8	10
5-Ton Dump Truck**	14	26	22	29
SEE	12	23	4	5
TOTAL	53	100	77	100

*Assumes 36 squads are reduced from 10 to 9 men, and 24 operators are added; 12 mechanics/support personnel are required.
**Not dedicated to squad or mobility/ countermobility vehicles.

Figure H-22

COMBAT SUPPORT EQUIPMENT COMPANY DESIGN RECOMMENDATIONS
(Key Equipment Only)

Key Equipment	Number	Percentage	Number	Percentage
Bulldozer	8	7	25	41
Front-End Loader	4*	7**	9*	15
Grader	9	7	0	0
20-Ton Dump Truck	28	69**	0	0
5-Ton Dump Truck	--	--	15	24
Wheeled Tractor With Scraper (18 CY)	9	7	0	0
SEE/JD410	3	3	12	20
TOTAL	61	100	61	100

*Loaders are 5 CY in current TOE and 2.5 CY in recommended TOE.
**Weighted percentage; one 20-ton truck = three 5 tons; one 5-CY loader = two 2.5-CY loaders.

Figure H-23

trucks were added; the 5-ton trucks give more responsive combat support than the heavier 20-ton dump trucks.

d. Figure H-24 summarizes the impact these equipment changes have on the individual unit's missions. The figure also shows the proponent headquarters that must overs·e any future changes. It is recommended that ADEA sponsor a test-bed for one airborne battalion and one light equipment company. The first of each of these units is now scheduled for 1992--far too long to wait.

RECOMMENDED ENGINEER EAD MISSION CHANGES

Engineer Unit	TOE Mission	ESC's Recommendation	Implementation
Corps Battalion (Wheeled)	Support Corps	Redistribute Equipment	TRADOC Decision
Abn Battalion	Reinforce Abn Bn*	Reinforce All Light Divisions (Abn, Ambl, 1t & MTZ)	ADEA Support POM Activation
CSE Company	Construction Equip Support	Redistribute Equipment For Survivability & Tank Ditching	TRADOC Decision
Light Equipment Company	Abn Const Equip Support	Reinforce All Light Divisions, Redistribute Equipment for Survivability	ADEA Support POM Activation

*Construct two medium-lift airfields within 72 hours.

Figure H-24

e. Figure H-25 summarizes the ESC's recommended equipment changes from the current TOE through the TOE changes forecasted for 1991. The 1991 changes are promising, but ESC believes that they are not enough.

f. Figure H-26 shows the impact of applying all of the recommended changes to EAD unit structures to the Case II (augmentation) scenario

COMPARISON OF TOE EQUIPMENT CHANGES

TOE and	TOE		
Key Equipment	H-Series	POM-91	ESC
5-35 Corps Bn			
Dozers/ACE	14	11	34
Graders	4	4	8
5-Ton Dump Trucks	14	20*	22
SEEs	12	9*	4
5-58 CSE Co			
Dozers/ACE	8	8	25
Loaders	4	4	9
Graders	9	9	0
20-Ton Dump Trucks	28	10*	0
5-Ton Dump Trucks	0	4*	15
Scrapers	9	9	0
SEE/JD410	3	3	12
5-195 Abn Bn			
Dozers	10	12*	24
5-Ton Dump Trucks	24	8	15
Scrapers	6	9	0
SEE/JD410	3	3	4
5-54 Lt Eq Co			
Dozers	12	12	30
Graders	9	9	0
5-Ton Dump Trucks	12	12	18
Scrapers	9	9	0
SEE	0	0	12

*Trend parallels study findings.

Figure H-25

requirements.   Squad- and equipment-hour totals for workloads completed are
not potrayed, since these projected force structures meet or exceed the vital
and critical hour requirements.   Squad-hours completed are 10 to 20 percent
over requirements, while equipment-hours are within 5 percent of requirements.

QUANTIFICATION OF ESC'S RECOMMENDATION
(Percentages)

Scenario Comparison	Case II Equipment-Hour Mix				
	ACE/ Dozer	Loaders	Graders	5-Ton Trucks	JD410 SEE
SWA					
Scenario requirement	41	13	8	29	9
Existing force structure*	22	9	9	38	22
Recommended force structure*	39	10	7	29	15**
Europe					
Scenario requirement	41	17	1	36	5
Existing force structure*	22	8	6	39	25
Recommended force structure*	39	9	7	31	15**

*Figure H-8 or H-10 force with and without ESC's recommended equipment
changes. (The EFFORT capability model was used for all calculations.)
**Excess SEE hours can be applied against the loader-hour deficit.

Figure H-26

(1)   In SWA, the existing EAD force structure has a 19-percent
dozer deficit and a 13-percent SEE surplus of equipment-hours.   With ESC
recommendations, no deficit exceeds 3 percent and the SEE surplus is lowered
to 6 percent.   ESC left the SEE total higher to respond to surge direct-fire
emplacements tasks.   At other times, the SEE surplus can be applied against
the 3-percent loader deficits or used when EAD units are absent.

(2)   In Europe, imbalances range from a 19-percent dozer deficit
to a 20-percent SEE surplus.   After ESC recommendations, deficits are lowered
to 8 percent or less and the SEE surplus is halved.   These new imbalances are

acceptable as this theater has secondary importance. In this scenario, as in the SWA scenario, the SEE surpluses can be used for loader deficits.

(3) In both scenarios, the dozer deficit is corrected to within 2 percent of the scenario requirement and the truck capability is leveled to about 30 percent. (The term dozer used here refers to either a standard D7 tractor or an ACE.)

9. Findings.

a. The engineer force structure for each theater requires:

(1) At least one corps engineer battalion to support forward brigades (less counterattacks).

(2) The SWA theater needs an airborne engineer package to support vital DRA tasks.

(3) With the addition of three to four corps engineer battalions (plus two CSE companies), the full EAD force can complete all critical priority tasks.

b. The combat corps companies (CSE and light equipment) need equipment to dig in weapon emplacements. All four corps units will increase bulldozers; redistribute loaders, graders, dump trucks, and SEEs between units; and eliminate scrapers.

10. Observations.

a. The engineer EAD force structure for the SWA scenario is seven battalions, compared to five battalions for the European scenario. This two-battalion difference seems to indicate the European theater is easier to support. However, the area defended in Europe is only 12 percent the size of the SWA divisional AO. The true meaning of the difference in support between the two theaters is based on the theater maneuver concepts. The differences

in threat forces and available host-nation facilities require the tactician to scale down motorized operation in Europe--and this is what was done. On equal areas of terrain, the European scenario is more difficult to support than SWA. The SWA terrain would require up to five divisions and 30 engineer EAD battalions if defended with heavy divisions; Europe would require one division and six engineer battalions (under this condition).

b. The study methodologies allowed ESC to recommend specific missions changes for each of four engineer EAD units. These changes point units to either one or multiple theaters, and have them support heavy and light forces or light forces only. These directions shift the focus of corps companies from construction support to combat support; direct what missions corps battalions should perform; and identify the future mission of units planned for 1992. The units planned for 1992 are patterned after existing airborne units stationed at Fort Bragg (TOEs 5-54H and 5-195H). ESC believes the additional "airborne" units should have missions appropriate to all types of light forces and be constrained only by C-141B transport (versus helicopter or parachute movement). Consequently, the existing units should stay in the H-series, while future TOE activiations should be made under the J-series. This allows Fort Bragg units to retain their airfield construction support missions for joint task forces, yet frees the new units for a cross-section of combat support tasks.

c. ESC has recommended that ADEA support early activations by converting a light equipment company (TOE 5-54J) and a light corps engineer battalion (TOE 5-195J). Some units were to convert in 1991, then 1992--now the date keeps slipping. Early activation would help finetune the unit sizes and compositions recommended in this annex. Testing also could determine if

the light corps battalion should be the EAD minimum support battalion, instead of the current wheeled version. Additional tests could be identified during conversions. There seems to be no reason to wait, as the equipment should be light (not necessarily of high mobility). This type of equipment is available for immediate use and testing, without costly research and development to convert it to combat tasks.

LAST PAGE OF ANNEX H

ANNEX I

DIVISIONAL ENGINEER BATTALION ORGANIZATIONAL STRUCTURE

ANNEX I

DIVISIONAL ENGINEER BATTALION ORGANIZATIONAL STRUCTURE

1. <u>Purpose</u>. This annex evaluates the design of the 9ID(MTZ) divisional engineer battalion to determine if it can meet the engineer support requirements during the key situations of the SWA and European scenarios considered by this analysis.

2. <u>Scope</u>.

a. This analysis evaluated the engineer support capability of the current organizational structure of the 9ID(MTZ) engineer battalion by:

(1) Comparing its support capability to the scenarios' support requirements during key battle situations of the SWA and European scenarios.

(2) Determining whether the battalion's engineer support capability was sufficient to satisfy the scenarios' requirements.

(3) Evaluating how adding more and different survivability tasks could affect the organizational structure.

(4) Recommending changes to improve the battalion's performance.

b. All of the improvements or adjustments made to the 9ID(MTZ)'s engineer battalion structure were made based on the assumption that the personnel strength indicated in its current TOE will remain the same and that its C-141 deployment sorties will not be increased.

3. Methodology.

   a. Capability comparisons. The design of the 9ID(MTZ ng   bat-
talion was evaluated by comparing two key aspects of the unit 's   ture:
its squad-to-equipment ratio and its individual equipment r   ility.
This evaluation was based on the "key situations" which occ   n   battle-
field during each scenario, as described in the main paper.   ho   uations
call for support to only vital and critical priority tas   Jh   y situa-
tions, which are the most important and difficult for th +   engineer
battalion to support, were dissected to determine where h   r workload
was concentrated on the battlefield and what work areas ad i t   ghest prio-
rity for engineers. ESC also used this same approach t det   e the impact
of asking the engineers to undertake more survivability t sks

   b. Study excursions comparisions. This stud on i red two major
study cases and five minor study excursions to those case . The analysis
described in this annex used four of the study's fiv excur ons in its meth-
odology: Excursions B, which places divisional en in rs forward; Excursion
C, which places EAD engineer units in the DRA; Excursion , which looks at the
impact on organizational design if only vital and critical tasks are com-
pleted; and Excursion E, which looks at the effect of asking the engineers to
dig in direct-fire anti-tank weapons. Although xcursion A, which evaluates
the impact of attaching a corps engineer battalion to the division, is not
directly considered here, it does influence divisional engineer capability.
The results of ESC's analysis of Excursion A are presented in more detail in
Annex H to this report.

4. Squad-to-Equipment Ratio.

   a. Figure I-1 shows the squad power to equipment capability ratios
for the 9ID(MTZ) engineer battalion and for various TOE configurations, and

SQUAD-TO-EQUIPMENT RATIO

	Percentage	
	Squad	Equipment
CAPABILITY:		
1986 TOE	37	63
TOE with ten 5-ton trucks	32	68
TOE with twenty 5-ton trucks	28	72
SWA REQUIREMENTS:		
Priority Groups		
Vital & critical	30	70
Essential & necessary	12	88
Time		
Pre-D-Day	27	73
60-hour delay	18	82
Battle zone		
Brigade areas	26	74
DRA	19	81
Key situation*	35	65
EUROPEAN REQUIREMENTS:		
Priority Groups	31	69
Vital & critical	7	93
Essential & necessary		
Time		
Lodgement and CFA delay	26	74
36-hour MBA delay	27	73
Battle zone	17	83
Brigade areas	32	68
DRA		
Key situation**	26	74

*First 36 hours of MBA delay; vital & critical priorities; brigade zones only.

**First 48 hours of CFA/MBA delay; vital and critical priorties; brigade zones only.

Figure I-1

gives the ratios required to satisfy the engineer requirements generated by each scenario. The scenario-requirement ratios are segregated to show those most pertinent to the divisional battalion mission. Of those shown, three have the most impact on engineer performance:

(1) Because of the short duration of the scenarios, vital and critical priority groups are more appropriate work tasks for divisional engineers. The essential and necessary priority groups either will not be done or will be tasks for EAD engineers.

(2) The pre-D-day period is important for divisional engineers, since augmentation engineers may not have arrived. The workload that occurs after D-day can be shared with other engineer units, but the divisional engineers must be able to accomplish lodgement and CFA initial preparations that occur before D-day.

(3) Divisional engineers should be structured for the work in the brigade areas. This design criterion is reinforced by the results of ESC's analyses of the excursions and the capability of EAD units. The EAD engineers are better structured for the DRA tasks, leaving the brigade areas the primary focus of the divisional engineer battalion. The close coordination and extensive combined arms training required for combat engineer support to the maneuver elements in the brigade areas can best be proved by the organic battalion. The brigade area workload is considerably greater than all of the divisional engineer capability--the battalion has no residual capability left to tackle tasks in the DRA.

b. Figure I-1 indicates the divisional engineer battalion has the proper squad-to-equipment ratio to accomplish vital and critical tasks in the brigade areas during the key scenario situations for both the SWA and European

I-5

scenarios. Consequently, no changes were recommended to the size of the battalion's current eight-man squad.

   5. Equipment Mix.

      a. Figure I-2 shows the battalion's dominant equipment distribution and the distribution reflected by the requirements of each scenario. Figure I-2 shows five dominant classes of equipment:

         (1) D7 bulldozer or ACE

         (2) The 2-1/2 cubic yard loader

         (3) A grader

         (4) The SEE or JD410 tractor (both with front-end loader and backhoe attachments)

         (5) Nondedicated 5-ton truck. In the divisional engineer battalion, all 5-ton trucks are considered dedicated since they are dedicated to pulling the MICLIC, Ground Volcano, or LAB trailors. However, if the MICLIC trailer or LAB trailers or both are parked, their 5-ton trucks are available for other tasks. To exploit these possibilities, two truck situations were tested; both changed the equipment mix capabilities of the divisional engineer battalion as shown in Figure I-2.

      b. The two scenarios' equipment mixes are different from capability in several ways. In Figure I-2, the SWA and Europe requirements show:

         (1) The SEE and ACE workload is not in proportion to the TOE capability; this imbalance changes by scenario.

         (2) The 5-ton truck capability tends to be inadequate unless many trailers are parked.

         (3) A third situation possibility listed in Figure I-2 corrects the potential SEE, ACE, and 5-ton truck distribution imbalance. This

EQUIPMENT DISTRIBUTION

	Dominant Equipment (Percentage)					
	ACE D7	Loader	Grader	5-Ton Trucks	SEE JD 410	Total
CAPABILITY:						
1986 TOE	43	--	--	--	57	100
TOE with LAB trailors parked[a]	35	--	--	19	46	100
TOE with LAB & MICLIC trailors parked	29	--	--	32	39	100
TOE with LAB & MICLIC trailors parked, minus 12 SEEs, & plus 8 ACEs	45	--	--	34	21	100
SWA REQUIREMENTS:						
Priority groups						
Vital & critical	32	15	9	42	2	100
Essential & necessary	47	11	7	21	14	100
Battle Zone						
Brigade areas	59	8	--	29	4	100
DRA	36	14	10	29	11	100
Key situation[b]	54	3	--	37	6	100
EUROPEAN REQUIREMENTS:						
Priority groups						
Vital & critical	24	21	1	47	7	100
Essential & necessary	89	7	1	3	0	100
Battle zone						
CFA operations	64	--	--	20	16	100
Brigade areas	60	8	1	19	12	100
DRA	27	24	1	48	0	100
Key situation[c]	25	9	--	39	27	100

[a]Same equipment mix if MICLIC trailors are parked and LAB trailors are hauled.
[b]First 36-hours of delay; vital and critical priorities; brigade zones only.
[c]48-hour delay; vital and critical priorities; brigade zones only.

Figure I-2

capability assumes all LAB and MICLIC trailers are parked, and that 12 SEEs are removed and eight ACEs are added to the battalion's inventory. This equipment mix favors the SWA conflict, but comes close to meeting the European scenario's requirements.

6. Excursions.

    a. Locating engineer requirements. Figure I-3 shows how ESC distributed engineer requirements in the division AO. For the purposes of this analysis, the AO was divided into three areas: zones where counterattacks were being executed; the remainder of the brigade areas; and the DRA. Note the low percentage of work required for counterattacks and the large percentage needed in the DRA. Each zone affects the design of the divisional battalion differently.

DISTRIBUTION OF REQUIREMENTS

Area	Scenario (Percentage)*	
	SWA	Europe
Counterattack zones in brigade areas or forward of the FEBA	4	0**
Brigade areas minus counterattack zones	36	23
DRA	60	77
Total	100	100

*Percentages based on key situation of each scenario.
**Short-gap bridging required; this is not part of the calculations.

Figure I-3

    (1) The division must be designed to support 100 percent of the workload for counterattacks. The workload is small and tasks are in the vital priority group. Requirements are comprised mostly of the M-1 task to breach

I-8

minefields and reduce other obstacles using the ACE. During the SWA scenario, this workload peaks at 18 ACEs; during the European scenario, six ACEs are required.

(2) The division can execute 50 percent of its vital priority brigade area tasks (minus counterattacks) in the European scenario (Annex H). However, this level of accomplishment is not possible for the SWA scenario. This workload is either mobility in the offense or countermobility in the defense. The critical priority tasks are reserved for EAD units. While the workload in the brigade area zone is only 23 to 36 percent of the total, depending on the scenario, it requires the capability of two engineer battalions to complete. Therefore, ESC recommended a design for the divisional engineer battalion that recognizes the EAD contribution to the divisions engineering capability in the brigade areas, by subtracting the capability of one corps engineer battalion.

(3) The large DRA requirement is the LOC workload--mostly critical priority tasks which move logistical supplies forward. This is an EAD requirement, because heavy construction equipment is required.

b. Dividing engineer capability.

(1) Study excursions B and C divided the engineer capability (Divisional and EAD augmentation) between the brigade areas and the DRA. The organic divisional battalion was assigned the brigade requirements (Excursion B), and the corps engineer battalion of the EAD force was assigned to the DRA (Excursion C).

(a) Figure I-4 compares the divisional engineer battalion's squad-hour capability with brigade requirements in Excursion B for all periods of the SWA scenario; Figure I-5 makes the same comparison for the corps

I-9

DIVISION CAPABILITY AND BRIGADE REQUIREMENTS
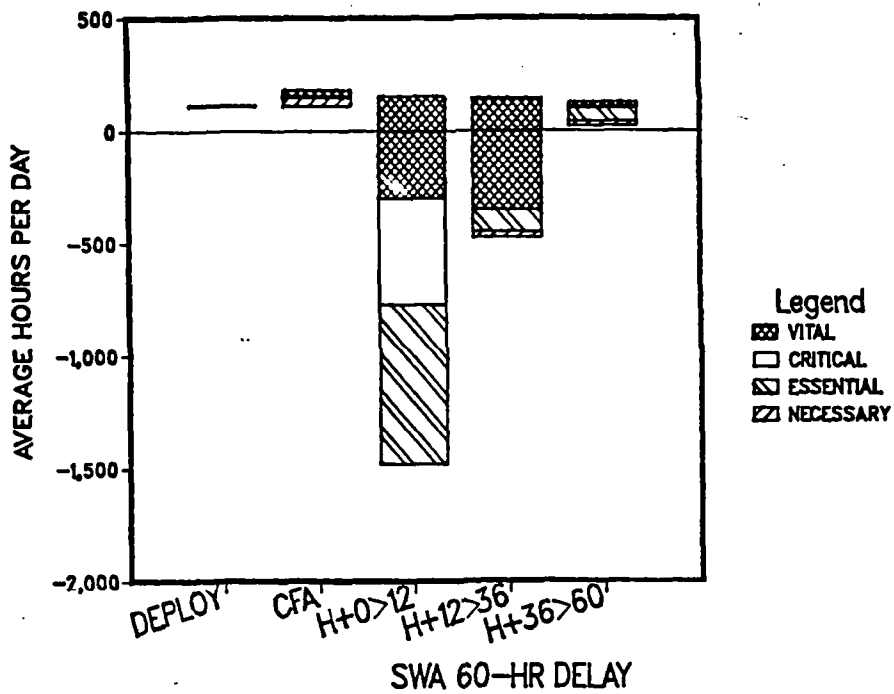## FOR THE SWA SCENARIO
Excursion B—Brigade Effort
(Squad-Hours)

Legend
- VITAL
- CRITICAL
- ESSENTIAL
- NECESSARY

SWA 60—HR DELAY

Figure I-4

CORPS CAPABILITY AND DRA REQUIREMENTS
FOR THE EUROPEAN SCENARIO
Excursion C—DRA Effort
(Squad-Hours)

Legend
- VITAL
- CRITICAL
- ESSENTIAL
- NECESSARY

SWA 60—HR DELAY

Figure I-5

I-10
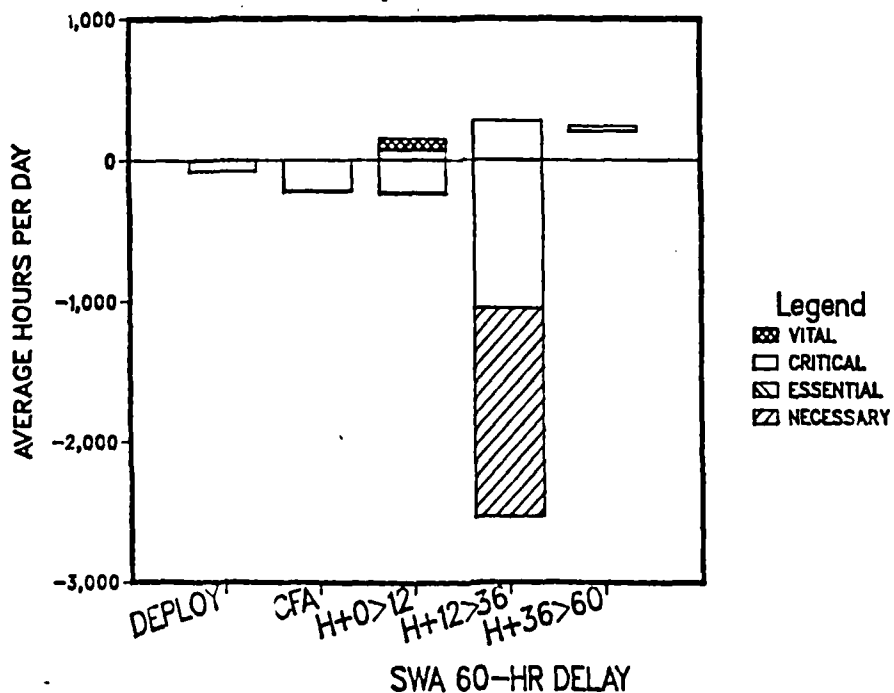
capability in the DRA for Excursion C. Figure I-6 shows the results of the comparsion of the divisional engineer battalion's equipment-hour capability with brigade requirements for Excursion B; Figure I-7 does the same for the corps in the DRA for Excursion C. Figures I-8 and I-9 are on a different scale than Figures I-4 through I-7; they show the details of the brigade and DRA equipment-hour requirements for the divisional engineer battalion and the corps under Excursions B and C during selected periods of the SWA scenario.

(b) Figures I-10 and I-11 compare the division and corps squad-hour capability with brigade and DRA requirements for Excursions B and C during all periods of the European scenario. Figures I-12 and I-13 make similar comparisons for equipment-hour capability.

(c) Figure I-14 summarizes the information in Figure I-4 through I-13 for the key situations of the SWA and European scenarios. The results shown in Figure I-14 indicate that more work in the DRA zone (Excursion C) is accomplished than in the brigade areas (Excursion B).

(2) The results of the analyses of Excursions B and C were combined with the findings of Excursion A, which evaluated the impact of attaching a corps battalion to the division. (In Excursion A, which is described in detail in Annex H, over 90 percent of the requirements were generated by the division; less than 10 percent were generated by the augmenting EAD force.) ESC's analyses of Excursions A, B, and C determined that:

(a) The divisional engineer battalion and corps engineer battalion should both focus their primary effort on the brigade areas. This finding is based on judgment that indicates it is imprudent to place one of the two engineer battalions in the DRA while vital brigade work is unexecuted.

(b) The divisional engineer battalion should be configured on the basis of the brigade requirements, including the requirements in the

DIVISION CAPABILITY AND BRIGADE REQUIREMENTS
FOR ALL PERIODS OF THE SWA SCENARIO
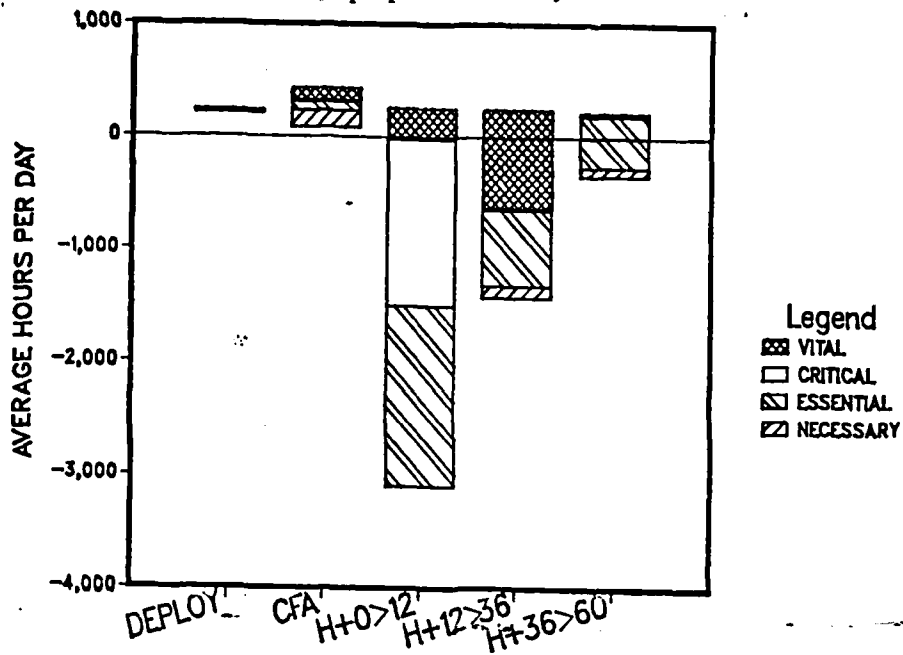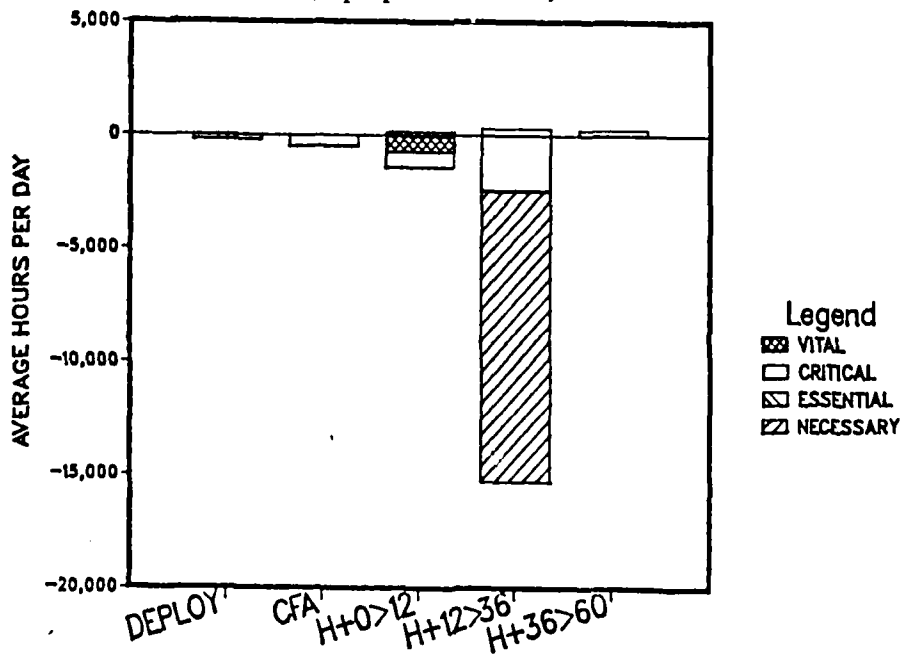Excursion B—Brigade Effort
(Equipment-Hours)

Legend
VITAL
CRITICAL
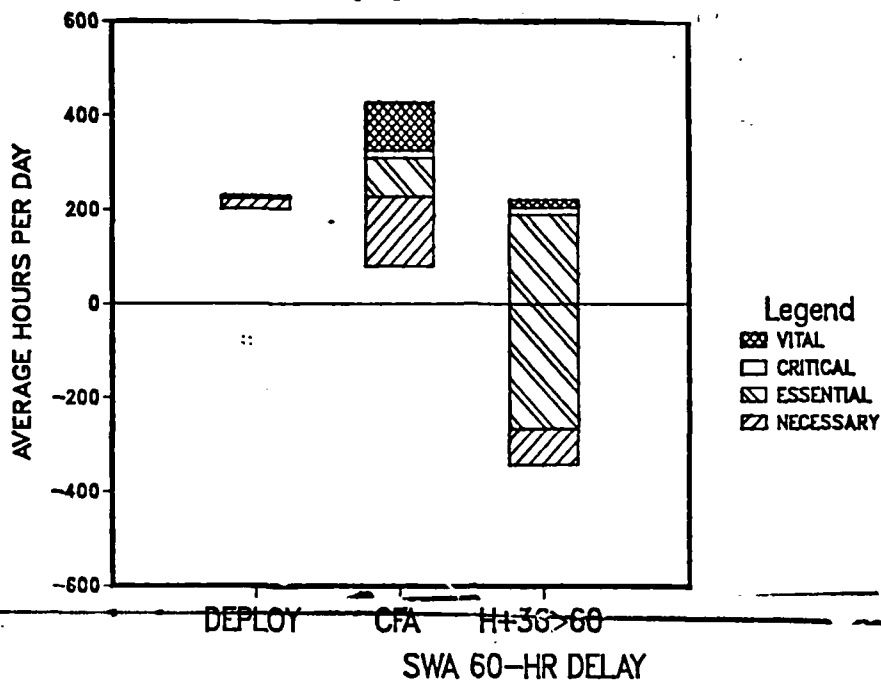ESSENTIAL
NECESSARY

SWA 60-HR DELAY

Figure I-6

CORPS CAPABILITY AND DRA REQUIREMENTS
FOR THE SWA SCENARIO
Excursion C—DRA Effort
(Equipment-Hours)

Legend
VITAL
CRITICAL
ESSENTIAL
NECESSARY

SWA 60-HR DELAY

Figure I-7

I-12

DIVISION CAPABILITY AND BRIGADE REQUIREMENTS
FOR PERIODS 1, 2, AND 5 OF THE SWA SCENARIO
Excursion B--Brigade Effort
(Equipment-Hours)

Figure I-8

CORPS CAPABILITY AND DRA REQUIREMENTS FOR
PERIODS 1, 2, AND 5 OF THE SWA SCENARIO
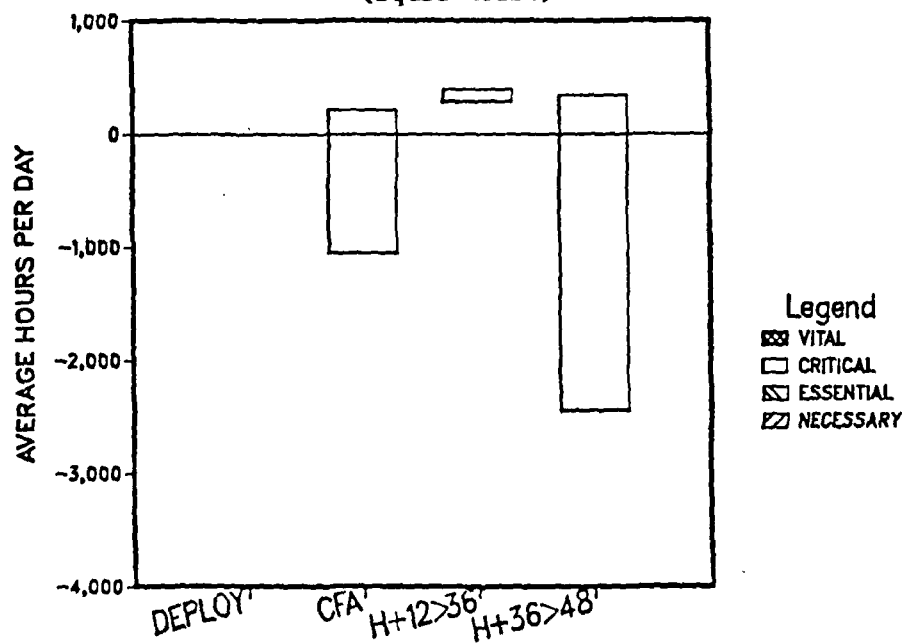Excursion C--DRA Effort
(Equipment-Hours)

Figure I-9

I-13
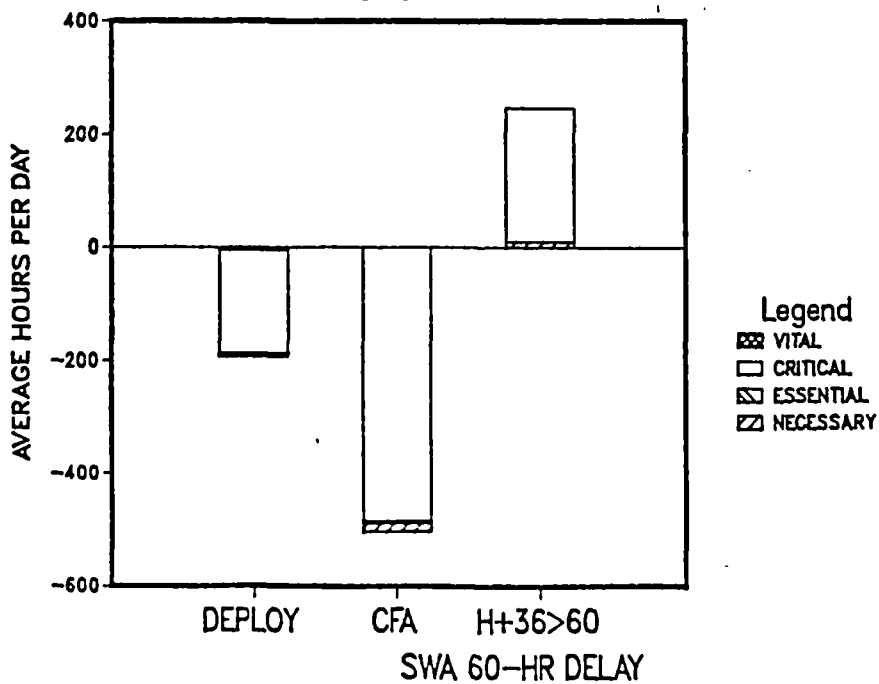
BRIGADE REQUIREMENTS FOR
THE EUROPEAN SCENARIO
Excursion B—Brigade Effort
(Squad-Hours)
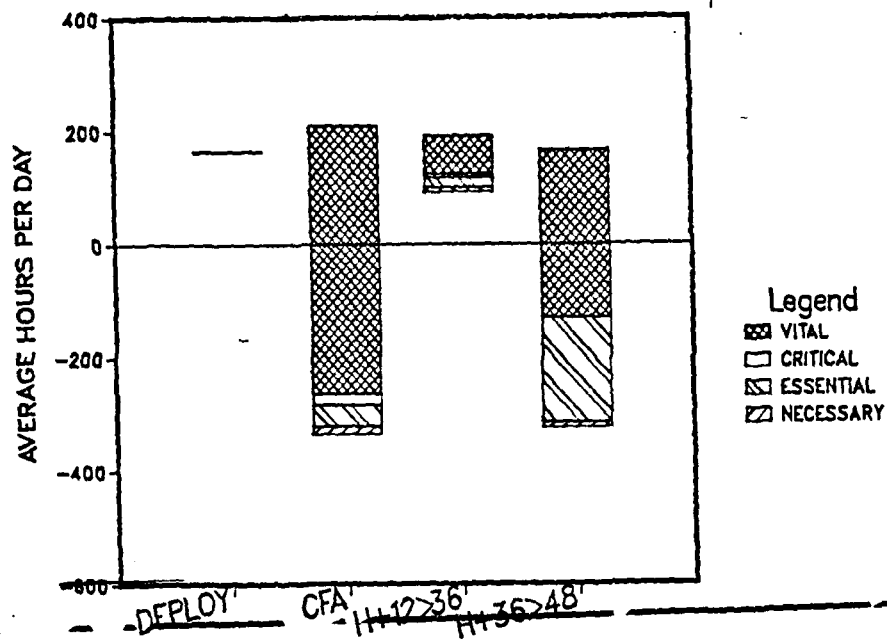
EUROPE 48–HR DELAY

Figure I-10

CORPS CAPABILITY AND DRA REQUIREMENTS
FOR THE EUROPEAN SCENARIO
Excursion C—DRA Effort
(Squad-Hours)

EUROPE 48–HR DELAY

Figure I-11

I-14

DIVISION CAPABILITY AND BRIGADE REQUIREMENTS
DURING THE EUROPEAN SCENARIO
Excursion B--Brigade Effort
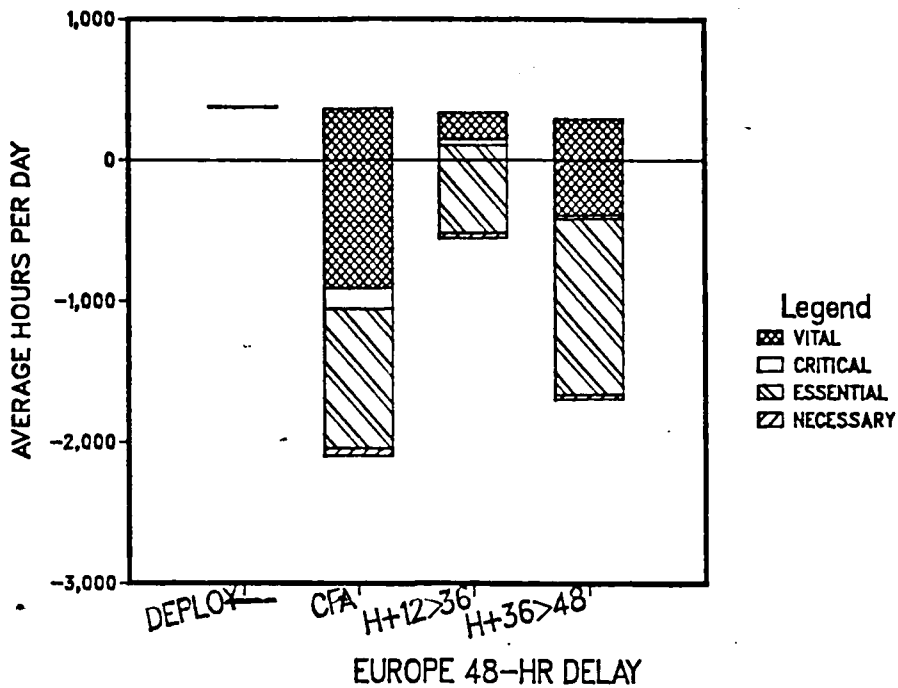### (Equipment-Hours)

Figure I-12

CORPS CAPABILITY AND DRA REQUIREMENTS
DURING THE EUROPEAN SCENARIO
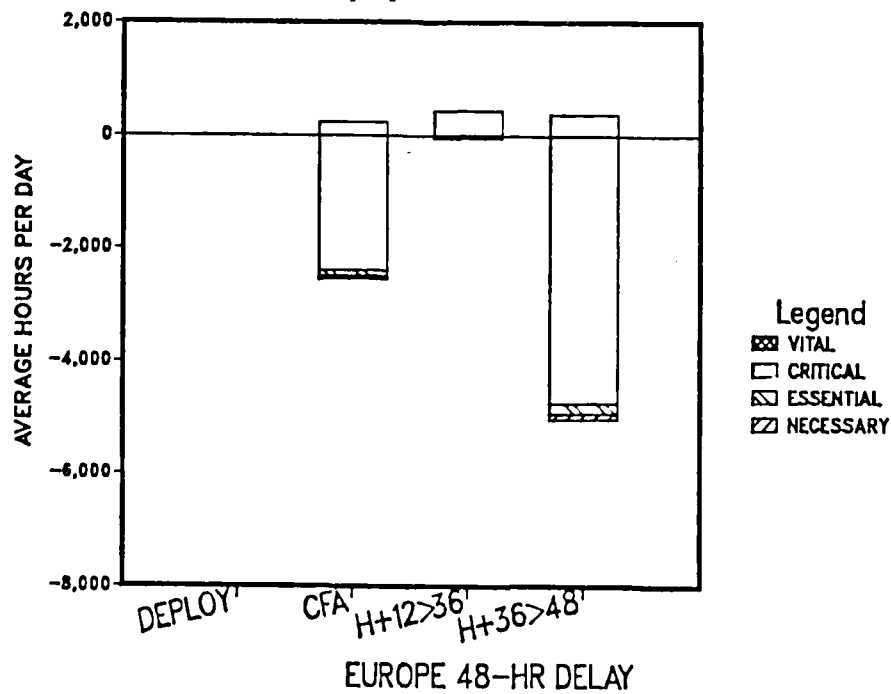### Excursion C--DRA Effort
(Equipment-Hours)

Figure I-13

END

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DTIC
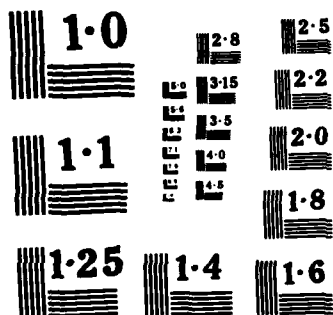
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

counterattack area. This finding is based on the fact that up to 46 percent of the total divisional work is in this zone. It is further supported by the fact that one engineer battalion can complete no more than 50 percent of this workload.

BRIGADE AND DIVISION REQUIREMENTS COMPLETED
(Excursions B and C)

Excursion	Scenario (Percentage)	
	SWA	Europe
Divisional engineer battalion capability versus brigade requirements (Excursion B)		
Vital priority group	36	64
Critical priority group	0	40*
Corps engineer battalion capability versus DRA requirements (Excursion C)		
Vital priority group	89	100
Critical priority group	23*	46

*Normally, 100 percent of the vital requirements must be met before critical requirements are begun; lower percentages shown in this figure are possible because time periods and squad- and equipment-hours have been consolidated and averaged.

Figure I-14

c. Direct-fire emplacements. Excursion E was conducted in response to the SAG guidance at IPR 3. At that briefing, the equipment distribution (Figure I-2) indicated SEE imbalances during the SWA scenario. This excursion was conducted for each scenario and explores the impact of digging in additional tactical vehicles on the engineer workload and on the equipment mix of the divisional engineers.

(1) In the initial analysis, the operational concept of the motorized division, combined with the open terrain and rapid fallback experienced in each scenario, prevented any direct-fire emplacements from

being built. But Excursion E tested three options; each dug in direct-fire weapons in various quantities. These three options are:

(a) Option 1: dig in all DRAGON portions using the engineer SEE vehicle.

(b) Option 2: dig in all direct-fire weapons; the SEE continues to dig in the DRAGONs, while the engineer ACE digs in all vehicle-mounted weapons.

(c) Option 3: dig in the same weapons as Option 2, but change the engineer equipment missions. (In this option, 164 LFV-mounted weapons are emplaced using the SEE instead of the ACE.)

(2) The results of Excursion E were analyzed using the methodology described in Annex E, except that the engineers were assumed to have 20 percent (SWA) or 10 percent (Europe) fewer weapons to dig in, since they were supporting maneuver units conducting rapid counterattacks. Thus, they did not require engineer support because they were moving to hide positions. Figure I-15 identifies the weapons dug in for each option and scenario. Only direct-fire weapons in the forward elements were considered. For example, of 810 divisional grenade machine guns, 198 were dug in. The planning factors and the results by scenario are shown in Figures I-16 and I-17.

DIRECT-FIRE WEAPON EMPLACEMENTS

| Type Weapon | Mode of Weapon Firing & Quantity | | | |
	Man-Carried	LFV	HMMWV	Other Vehicle*
DRAGON	135			
TOW		72		
MK-19 grenade machine gun		92	106	
PGATM			36	
Assault gun				144

*The assault gun vehicle was an unknown for this study, so APC-size emplacements were assumed.

Figure I-15

I-17

DIRECT-FIRE EMPLACEMENT PLANNING FACTORS

Weapon	Number of Emplacements Per Battle	Total Equipment Hours (Per Weapon Per Battle)	
		SEE[a]	ACE[b]
DRAGON	3	0.2	
Vehicle-Mounted[c]	2		0.9
LFV-Mounted	2	2.5	

[a]DA, Armor and Engineer Board, Strongpoint Emplacement Excavation for Defensive Operations, Concept Evaluation.
[b]DA, USAES, Engineer Family of Systems Study (E-FOSS).
[c]LFV or HMMWV.

Figure I-16

REQUIREMENTS FOR DIRECT-FIRE EMPLACEMENTS

Option	SWA Scenario[a]				European Scenario[b]			
	SEE		ACE		SEE		ACE	
	Number	Hours	Number	Hours	Number	Hours	Number	Hours
DRAGON only	653	131	--	--	690	138	--	--
All direct-fire weapons	653	131	4,354	1,959	690	138	5,049	2,272
All direct-fire weapons with equipment change[c]								
DRAGON	653	131	--	--	690	138	--	--
LFV	1,586	1,983	--	--	1,089	1,361	--	--
HMMWV & AG	--	--	2,903	1,306	--	--	3,960	1,782
TOTAL	2,239	2,114	2,903	1,306	1,779	1,499	3,960	1,782

[a]36-hour MBA delay.
[b]48-hour MBA delay.
[c]Option 3 with all LFV positions dug in by SEE.

Figure I-17

I-18

(3) Figure I-18 shows the impact the requirement to dig direct-fire weapon emplacements has on the engineer workload.

ENGINEER EAD FORCE STRUCTURE
(Direct-Fire Excursion)

MBA Delay Situation and Scenario	Engineer EAD Force Unit(s)	
	Lt Equip Co (ABN)	CSE CO
No direct-fire emplacements		
SWA	--	--
Europe	--	--
DRAGON emplacements only*		
SWA	--	--
Europe	--	--
DRAGON & all vehicle direct-fire emplacements**		
SWA	1	2
Europe	1	1
All direct-fire emplacements substituting the SEE for the ACE to dig in weapons mounted on the LFV		
SWA	--	4
Europe	--	2

*The SEE digs in DRAGON emplacements.
**The ACE digs in all direct-fire weapons mounted on a LFV or HMMWV.

Figure I-18

(a) Figure I-18 expresses this increase as additions to the EAD force structure. ESC determined which units should be increased by translating the capability of the light equipment (airborne) and CSE companies into hypothetical equipment-hours by assuming, for the purposes of analysis, that these units only contained ACEs and SEEs. When this somewhat artificial expression of the capability of the companies' true equipment mix was validated, the resulting equipment mix for the restructured, larger EAD units,

I-19

would change as the SEEs and ACEs in these two units were redistributed to other units.

(b) It can be seen that DRAGON emplacements have a minor effect on the engineer workload, but the impact of vehicle emplacements on the engineer workload is major. The workload represented by digging in all vehicle emplacements is equivalent to the capability of an entire engineer equipment battalion. Using the ACE for all vehicle emplacements is one engineer company more efficient than when a mix of ACEs and SEEs is used.

(4) Figure I-19 shows the impact this workload has on the distribution of total engineer requirements in the division AO. Note that the additional workload increases in the brigades and decreases in the DRA. This shift is again most pronounced when all direct-fire weapons are emplaced. However, even for the worst option, the total increase of workload in the brigade, minus the area compared to the counterattack zone, is less than 10 percent. Therefore, this part of the excursion does not change ESC's decision to base the divisional engineer battalion's organizational design on the requirements found in the brigade areas plus those found in the counterattack zone.

(5) This excursion affects the equipment distribution of the divisional engineer battalion under any of the three options. Figures I-20 and I-21 show these changes, first in terms of requirement percentages, then in terms of actual TOE equipment. Both scenarios increase ACEs at the expense of SEEs when all direct-fire weapons are dug in. The European scenario also has a decreasing 5-ton truck requirement as the digging-in requirement increases.

WORKLOAD DISTRIBUTION
(Direct-Fire Excursion)

MBA Delay Situation and Scenario	Divisional AO Workload Zone Percentage		
	Counterattack Zones	Brigade Minus Counterattack Zones	DRA
No direct-fire emplacements			
SWA	4	36	60
Europe	0	23	60
DRAGON emplacements only*			
SWA	4	37	59
Europe	0	24	76
DRAGON & all vehicle direct-fire Emplacements**			
SWA	4	45	51
Europe	0	32	68
All direct-fire emplacements substituting the SEE for the ACE to dig in weapons mounted on the LFV			
SWA	4	52	44
Europe	0	34	66

*The SEE digs in DRAGON emplacements.
**The ACE digs in all direct-fire weapons mounted on an LFV or HMMWV.

Figure I-19

I-21

SCENARIO EQUIPMENT DISTRIBUTION
(Direct-Fire Excursion)

MBA Delay Situation & Scenario	Equipment Distribution (%)			
	ACE	Loader	5-Ton Truck	SEE
No direct-fire emplacements				
SWA	54	3	37	6
Europe	25	9	39	27
DRAGON emplacements only*				
SWA	50	3	34	13
Europe	24	9	37	31
DRAGON & all vehicle direct-fire emplacements**				
SWA	76	1	17	6
Europe	63	4	18	15
All direct-fire emplacements substituting the SEE for the ACE to dig in weapons mounted on the LFV				
SWA	44	1	13	43
Europe	43	3	15	38

*The SEE digs in DRAGON emplacements.
**The ACE digs in all direct-fire weapons mounted on an LFV or HMMWV.

Figure I-20

7. Findings.

    a. The divisional engineer battalion design of 1986 has:

        (1) The proper squad-to-equipment ratio.

        (2) Enough ACE capability to support maneuver counterattacks.

EQUIPMENT DISTRIBUTION IN DIVISIONAL ENGINEER BATTALION
(Direct-Fire Excursion)

MBA Delay Situation and Scenario	Divisional Engineer Battalion TOE Quantities[a]		
	ACE	5-ton Truck	SEE
1986 TOE capability (Reference Point)	18	20[b]	24
No direct-fire emplacements			
SWA	29	20	6
Europe	15	24	22
DRAGON emplacements only[c]			
SWA	28	20	8
Europe	15	23	24
DRAGON & all vehicle direct-fire emplacements[c]			
SWA	30	20	4
Europe	34	10	12
All direct-fire emplacements substituting the SEE for ACE to dig in weapons mounted on the LFV			
SWA	27	16	39
Europe	27	10	27

[a]Converts TOE equipment to match requirements without exceeding current C-141B sorties. For conversions: 2 SEEs = one 5-ton truck; 1.67 SEEs = one ACE; and 1.2 ACEs = one 5-ton truck.

[b]Assumes MICLIC and LAB are parked or towed by ACEs, freeing twenty 5-ton drop-side trucks.

[c]See Figure I-20 for explanations.

Figure I-21

(3) Not enough capability to do vital brigade tasks unless it is joined in the brigade areas by at least one corps engineer battalion.

(4) A workload centered and located on the fallback portions of the brigade area.

(5) A deficiency in work-site transport capacity that can only be corrected if LAB and MICLIC trailers are parked and their dedicated trucks used for other tasks.

(6) An ACE and SEE distribution that is not optimal for a particular theater, but balanced when both contingencies are equally considered and not weighted towards SWA.

(7) Not enough capability to dig in direct-fire weapons if these emplacements are required.

(8) A possible need to redistribute bulldozers and SEE backhoes, depending on the number of survivability missions the 9ID(MTZ) is going to undertake.

b. Figure I-22 presents the ESC's recommended divisional engineer battalion design. This design removes 12 SEEs and adds eight ACEs. The design criteria are:

(1) Key situation tasks. The design is based on the key situation of both scenarios. These situations have the highest priority tasks and the largest capability shortfalls.

(2) Brigade area requirements. The design must support the brigade area plus counterattack zones, since this is where the most important work is located.

(3) No direct-fire emplacements. The design does not include the requirement for direct-fire emplacements. The provision of direct-fire

emplacements would require an additional engineer battalion of effort or, more preparation time for the divisional battalion to work on this task than the scenarios now provide. This workload is more appropriate for an Engineer EAD unit or units.

REDESIGN OF ENGINEER BATTALION EQUIPMENT

Requirement and Capability	Dominant Unit Equipment			
	ACE	Loader	Truck	SEE
Key Situation (%)				
SWA	54	3	37	6
Europe	25	9	39	27
Weighted average[a]	44	5	38	13
Capability				
1986 design TOE (%)	29	--	32	39
(Actual Quantities)	(18)	--	(20)[b]	(24)
ESC-recommended (%)	45	--	35	21[c]
(Actual Quantities)	(26)	--	(20)[b]	(12)

[a]SWA = double weight, and Europe = single weight.
[b]Assumes LAB and MICLIC 5-ton drop side trucks are available.
[c]Percentage increased to offset lack of loaders in unit.

Figure I-22

(4) SWA scenario. Since, the SWA scenario better reflects the divisional operational concept, it is used as the primary influence in unit redesign. The European deployment is a secondary mission and thus is used as a secondary influence. An equipment mix was selected based on a 2:1 ratio of the SWA to Europe scenario for each key situation. The 2:1 weighted average was selected based on the difference in equipment shortfall between the two scenarios. In the SWA scenarios, engineers accomplish almost twice the vital workload of the equivalent European workload.

LAST PAGE OF ANNEX I

ANNEX J

BIBLIOGRAPHY

ANNEX J

BIBLIOGRAPHY

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LAST PAGE OF ANNEX J

ANNEX K

STUDY REVIEW COMMENTS

ANNEX K

STUDY REVIEW COMMENTS

1. <u>Purpose</u>. At the completion of this study ESC published a draft report that was distributed for review and comment to the study sponsor, the Study Advisory Group, and a select list of agencies interested in the study topic. This annex documents the results of their review process.

2. <u>Scope</u>. This annex presents only the significant and substantive comments ESC received on the draft report. No editorial comments are included since they were automatically incorporated in the final report, either in response to the review comments or as part of ESC's routine editorial process. All comments were received by the study sponsor, then reviewed, consolidated and sent to ESC on 26 September 1985.

3. <u>Disposition of Comments</u>. This paragraph lists each substantive comment ESC received on the draft report, followed by a description of the action ESC took as a result of the comment.

    a. COMMENT: "The recommendations of reducing the number of Light Assault Bridges and increasing the number of Volcano systems is valid for the two scenarios used in the study. Original design for the motorized engineer battalion required ten Volcano systems. This number was reduced to six

systems due to sortie constraints on the battalion. Although there is a requirement for additional Volcano systems, a risk analysis using a wide spectrum of missions does not warrant replacement of Light Assault Bridges with Volcano systems. Contingency operations will often involve the need to conduct gap crossings in varied environments. Reducing the overall number of Light Assault Bridges will decrease the division mobility capability. The ability to support gap crossings would be dangerously low in the brigade areas and may not provide an adequate short gap crossing response. An up front caveat in the study report stating that some recommendations are terrain dependent would be appropriate". RESPONSE: The Executive Summary to the final report explains that ESC's recommendations depend on doctrine, TOE configurations, and most importantly, the conditions of the scenario.

b. COMMENT: "Recommendations concerning changing the force structure of EAD units were made based on this analysis. Since those recommendations are based on two scenarios and one specialized division, a comment should be included to this effect." RESPONSE: The recommended changes were based both on this analysis and previous ESC analyses of the III, V and VII US Corps in Europe. ESC determined that when essential and necessary tasks in the DRA are considered, the equipment mix for engineer EAD units is similar for all divisions and theaters. This observation has been added to the methodology statement in both the main report and Annex H (Engineer EAD Force Structure).

c. COMMENT: "The conclusions developed in the study concerning tank ditching by TEXS and the ACE may not be supported by the recently completed TEXS Cost and Operational Effectiveness Analysis or the M9 ACE Follow-on Evaluation conducted at Fort Hood, Texas. Although TEXS requires Class V supply

and the manhours on site to lay, fill and detonate the explosives, it requires less total mission time. As explained in the COEA, TEXS represents a new and significant addition to the maneuver commander's countermobility capability. With equipment shortfalls identified in the study, the use of TEXS permits reallocation of engineer equipment to support the other critical engineer battlefield functions of mobility, survivability, and general engineering."
RESPONSE: The follow-on evaluation by Fort Hood was published in August 1985, after ESC's July 1985 draft study report was completed. Figure K-1 compares the Fort Hood data to the study's findings and to information recently obtained from the Caterpillar Company. The TEXS emplacement time is much less than that of the two ACEs or two D7 bulldozers used at Fort Hood. However, these test data conflict with data from both the Caterpillar Company and other sources used by the study, including FM 5-102.[1] Given the date of these new conflicting data and the overriding deployment and logistic considerations of the study's short scenarios, ESC's findings have not been changed. For longer scenarios, or for scenarios where the US Army is forward deployed, the TEXS system provides a superior tank ditch.

d. COMMENT: "LAB/MICLIC holding areas must be well forward after deployment. Mobility will be a division priority regardless of the ongoing operations." RESPONSE: Agree. No action is required since the study scope excluded command and control considerations.

e. COMMENT: "Engineer capability can be further augmented by infantry collective tasks; e.g., wire obstacles, conventional mines, and simple demolitions. This was not incorporated into the overall division engineer

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[1]Caterpillar Tractor Co., Caterpillar Performance Handbook; and DA, HQ, FM 5-102, Countermobility.

capability assessment." RESPONSE: The intensity and limited duration of the scenarios did not present likely opportunities for significant engineer capability augmentation by non-engineer divisional elements. Tasks normally considered to be engineer related, such as protective positions, protective minefields, unit wire obstacles, and non-standard wire road blocks were assumed done by non-engineer units and therefore were not identified as requirements.

1000-METERS OF ANTI-TANK DITCH

Source	Equipment-hours*	Remarks
FM 5-102, Countermobility, March 1985	28 (M9 ACE)** 28 (D7)**	Based on European testing in OPERATION LINEBACKER, 1976, and conversions from D7 to M9 data in E-FOSS
Caterpillar Performance Handbook,	24 (D7)	Push distance of 10 meters, and average operator
October 1984	18 (D7)	Push distance of 10 meters, and excellent operator
M9 ACE Follow-On Evaluation, August 1985	78 (M9 ACE) 62 (D7)	Phase II (on-site), Fort Hood Test, daylight with no MOPP conditions
	42 (M9 ACE) 26 (D7)	Phase III (FTX), Fort Hood Test, daylight with no MOPP conditions

*Two ACEs or Two D7s working in tandem.
**Data used for this study.

Figure K-1

f. COMMENT: "Engineer squads can provide haul capacity only for personnel, organic equipment, and basic loads. Haul capacity for Class IV and Class V missions must be provided from the BSA to CFA/MBA by the maneuver brigades (i.e., support battalions)." RESPONSE: ESC assumed engineer project

materiel would be moved by engineers from the BSA to project sites. This assumption was validated with the DISCOM on 15 November 1984 during ESC's data collection trip. The assumption is based on information given in Operational Concept, 9th Infantry Division (Motorized), Part I, "The Division Concept".[2] Annex H of Part I states Class IV and V supplies will use supply point distribution at a forward distribution point at each BSA. This concept document also states that "A very limited capability for unit distribution or resupply at designated rendezvous points does exist within the division." The assumption is reasonable, given the priority of Class V for all weapon systems, the limited availability of scenario backup logistics, the widely dispersed engineer site locations (many isolated from any other division unit), and the short time spent by engineers at their project sites. However, if delivery to the project sites could be guaranteed (experience indicates this is unlikely), the recommendation to add six 5-ton trucks could be withdrawn and the engineer battalion could stay at its current 26-truck level.

g. COMMENT: "The draft Handbook of Employment Concepts for Mine Warfare, November 1985, specifies Volcano and GEMSS minefield module sizes smaller than those used in the analysis of the engineer requirements for the 9ID(MTZ). The conclusions developed in the study concerning minefield requirements may not be supported by this current assessment of Volcano and GEMSS capability." RESPONSE: The draft handbook was distributed in October 1985, after ESC's July 1985 draft study report was completed.[3] Based on the countermobility methodology, the revisions do not change logistical

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[2]DA, ADEA, Operational Concept--9th Infantry Division (Motorized)--Part I, The Division Concept; Part II--Unit Concepts; Part III--Equipment and Systems Concepts (FOUO).
[3]DA, USAES, Handbook of Employment Concepts for Mine Warfare Systems.

calculations and ASR recommendations. The handbook's revisions would increase the number of minefield modules and reduce Ground Volcano emplacement times. The implications of more modules and fewer emplacement hours in terms of total scenario engineer effort, however, are minor and even further support the attractiveness of Air Volcano. Given the study time frame and insignificant scenario impact, ESC's findings have not been changed.

LAST PAGE OF VOLUME I

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